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The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Proposed Tunnel Under the Mersey.

Science and Industry in America—No. IV.

Shipping, Engineering and Machinery Exhibition at Olympia—No. VI.

The Locomotive Booster.

Electricity in Mines—No. X.

State Railways.

The Ideal Seaport.

Boiler Feed Water Circuits in Power Stations.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, REQUIRES :—
1. BODY IRONWORK, &c., for RAILWAY CARRIAGES.
2. BUFFERS, WELDLESS, and BUFFER SOCKETS.
3. WHEELS and AXLES and WHEEL CENTRES.
4. SPRINGS, HELICAL and VOLUTE.
5. TYRES for CARRIAGES and WAGONS.
6. IRON FIRE-BARS.
Tenders due on the 30th October, 1923, for No. 1, on the 18th October, 1923, for Nos. 2 to 5, and on the 25th October, 1923, for No. 6.
Tender forms obtainable from above. 3702

India Store Department. APPLICANTS for the POST of ASSISTANT ENGINEER INSPECTOR are informed that both VACANCIES have now been FILLED. 3744

Applications are Invited in respect of a VACANCY for a SENIOR SCIENTIFIC ASSISTANT in the EXPERIMENTAL DEPARTMENT of H.M. SIGNAL SCHOOL, PORTSMOUTH.
2. The duties are to take charge of the section dealing with investigation and development of receiving apparatus for wireless telegraphy as used for naval purposes.
3. Applicants should possess an Honours Degree in Physics or Electrical Engineering, and it is essential that they should have had considerable experience of independent research in wireless telegraphy or allied electrical subjects.
4. The salary scale is £500, rising by annual increments of £25 to £600 per annum, plus Civil Service bonus. The present total value of £500 is £684 approximately. The appointment will carry superannuation benefits and will be, in the first instance, for three years.
5. Applications, giving full particulars of age, nationality, scientific experience, publications, war experience, &c., should be addressed to the SECRETARY of the ADMIRALTY (C.E.), Whitehall, London, S.W. 1, not later than the 10th October next. 3637

Draughtsman, Experienced in Heavy Oil Internal Combustion Engines, REQUIRED for POSITION of ASSISTANT DESIGNER in the Admiralty Engineering Laboratory, West Drayton, at a salary of £160 per annum, plus Civil Service bonus.
Written application should be made to the SUPERINTENDENT, Admiralty Engineering Laboratory, West Drayton, stating age and giving full details of previous experience, with approximate periods employed at each firm and position. 3756

Executive Engineer Re- QUIRED by the GOVERNMENT of SIERRA LEONE for the PUBLIC WORKS DEPARTMENT, for two tours of not less than 12 nor more than 18 months' continuous residential service, with possible extension. Salary £480, rising by annual increments of £30 to £720 per annum, and thence to £920 a year by annual increments of £40. Liberal leave in England on full salary. Free quarters and passages. Candidates, age 25 to 35, preferably unmarried, must have served articles with a corporate member of the Institution of Civil Engineers and have passed the examination qualifying for A.M. Inst. C.E., or possess the Diploma of some recognised Engineering College which exempts candidates for the Associate Membership from taking the Institution examination. Must be good draughtsmen, capable of designing and carrying out buildings, bridges and other engineering structures, and of taking out quantities and preparing detailed plans and estimates. Must be competent to execute surveys and to lay out and construct roads. Should have had practice and general experience as civil engineers on the construction of roads, buildings, and other public works.
Apply at once by letter, stating age, qualifications, and experience, and whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/12,307. 3757

Mechanical Engineer, to act as WORKS MANAGER and MECHANICAL ADVISER for the UGANDA RAILWAY and MARINE SYSTEMS, REQUIRED by the GOVERNMENT of KENYA for two years, with possible permanency. Salary £1100 a year. Free quarters and passages and liberal leave in England on full salary.—Candidates, aged 30-40, must have held similar controlling appointments on an important railway and should preferably have also had experience of marine engineering.—Apply at once by letter, stating age and giving brief details of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/12,087. 3096

Stores Assistant Re- QUIRED for the FEDERATED MALAY STATES GOVERNMENT RAILWAY for 3 years, with possible permanency. Salary 400 dollars a month, rising by annual increments of 25 dollars a month to 600 dollars a month, plus a strictly temporary cost of living allowance amounting to 10 per cent. of salary in the case of a single man, and for a married man 80 dollars a month. Government rate of exchange is now 2s. 4d. to the dollar, but the purchasing power of the dollar in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free passage and, if married, for wife and children also, not exceeding four persons. Candidates, aged 26 to 35, must possess a general knowledge of stores and storekeeping (railway preferred), including buying, examination, storing, accounting and auditing.—Apply at once by letter, stating age and particulars of experience and also whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/12,285. 3695

The Madras and Southern MAHRATTA RAILWAY COMPANY, LTD.
The Directors are prepared to receive TENDERS for 3000 STEEL BOILER TUBES, Solid Drawn, in accordance with the specification, which may be seen at the offices of the Company. The charge for the specification is One Guinea, which will not be returned.
Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, 23rd October, 1923, and marked "Tender for Boiler Tubes."
The Directors do not bind themselves to accept the lowest or any Tender.
Company's Offices :
25, Buckingham Palace-road, Westminster, S.W. 1.
2nd October, 1923. 3743

PUBLIC NOTICES

The University of Sheffield.

SESSION 1923-24.

Vice-Chancellor :
SIR HENRY HADOW, C.B.E., D. Mus., LL.D.

DEPARTMENTS OF MECHANICAL, ELECTRICAL, AND CIVIL ENGINEERING, METALLURGY, MINING, FUEL TECHNOLOGY, AND GLASS TECHNOLOGY.

The Courses in the DEPARTMENT of ENGINEERING extend over three or four years and prepare students to become Mechanical, Electrical, Civil or Mining Engineers, or specialists in Fuel Technology or Glass Technology.
The Courses in the DEPARTMENT of METALLURGY cover a period of three or four years and prepare students for positions of responsibility either (1) in Iron and Steel Manufacture, or (2) in the Non-ferrous Metallurgical Industries.
The LECTURE COURSES in all the Departments are supplemented by Practical Training in Laboratories and Workshops, which are fully equipped for the purpose of advanced scientific teaching, investigation and research.
Part-time Courses are arranged for students who desire to take special portions of any of the regular courses.
In Mining Engineering and in certain of the Courses in Mechanical and Electrical Engineering and in Glass Technology, arrangements are made to enable students, who come to the University from works or collieries, to take six months' courses of study at the University and six months' practice at the works or colliery each year for a period of four years.
The LECTURE COURSES commence OCTOBER 3rd, 1923.
The TECHNICAL LABORATORY COURSES commence SEPTEMBER 25th, 1923.
For further details of the Courses and for particulars of the Degrees, Associateships, Diplomas, and Certificates awarded on their successful completion, application should be made to
W. M. GIBBONS,
3390 Registrar.

Karachi Municipality, India. WATERWORKS.
The Municipality is prepared to receive TENDERS for the following :—
(1) DEEP-WELL THREE-THROW PUMPS in DUPLICATE, with Shafting, Gears and other Appurtenances, capacity of each unit nine million gallons per 24 hours.
(2) CAST IRON WELL LININGS and GAUGE PLATES.
(3) STEEL CHIMNEY SHAFT.
(4) TRAVELLING CRANE.
All in accordance with drawings, general conditions and specifications prepared by Messrs. John Taylor and Sons, Civil Engineers, 36, Victoria-street, Westminster, S.W. 1, at whose offices the drawings may be seen and copies of the specifications and forms of Tender obtained upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.
Specifications will only be issued to bona fide makers of the respective articles called for.
Sealed Tenders, addressed to the Municipality, are to be delivered at 36, Victoria-street, Westminster, S.W. 1, on or before Thursday, 8th November, 1923, addressed to the Municipality, care of the Consulting Engineers.
The Municipality does not bind itself to accept the lowest or any Tender.
MEASHAM LEA, Esq., O.B.E., M. Inst. C.E.,
Engineer-in-Chief, Karachi Municipality.
Messrs. JOHN TAYLOR and SONS, MM. Inst. C.E.,
3715 Consulting Engineers.

PUBLIC NOTICES

Appointments Board of the IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY,
including :—
ROYAL COLLEGE OF SCIENCE,
ROYAL SCHOOL OF MINES,
CITY AND GUILDS (ENGINEERING) COLLEGE,
SOUTH KENSINGTON, S.W. 7.
EMPLOYERS REQUIRING MEN who have received a thorough training in the principles of Engineering and who have obtained the Diploma of the City and Guilds (Engineering) College are asked to MAKE USE of the SERVICES of the BOARD. No fee.
These men have received instruction (including practical work in the extensive and well-equipped laboratories of the College) in Civil, Mechanical, and Electrical Engineering, including Mathematics, Physics, and Chemistry. Their training has been such that they are capable of specialising in any branch of Engineering that may be offered. 3703

Bengal-Nagpur Railway Company, LIMITED.
The Directors are prepared to receive TENDERS for :
(1) 30 "H.S." CLASS LOCOMOTIVES, 5ft. 6in. Gauge.
(2) 4 "B.S." CLASS LOCOMOTIVES, 2ft. 6in. Gauge.
Specifications and forms of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, as follows :—
(1) The "H.S." Class Locomotives, on or after Friday, the 28th September, 1923.
(2) The "B.S." Class Locomotives, on or after Monday, the 1st October, 1923.
A fee of £1 1s. will be charged for each specification, which is not returnable.
Tenders must be submitted not later than Noon on Friday, 12th October, 1923.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
R. C. VOLKERS,
3713 Secretary.

Metropolitan Water Board. TENDERS FOR THE MANUFACTURE, DELIVERY AND FIXING OF EIGHT WATER-TUBE BOILERS, PIPING, &c., AT THE WALTON PUMPING STATION, SURREY.
The Metropolitan Water Board invite TENDERS for the MANUFACTURE, DELIVERY and FIXING of EIGHT WATER-TUBE BOILERS, SUPERHEATERS, ECONOMISERS, WATER SOFTENER, FEED PUMPS, PIPING, &c., at their Walton Pumping Station, Surrey.
Forms of Tender, conditions of contract, specification and drawings may be inspected without payment of fee at the offices of the Board (Room 173), Chief Engineer's Department, 173, Rosebery-avenue, Clerkenwell, E.C. 1, on and after Monday, 8th October, 1923.
Contractors desirous of tendering may obtain the necessary documents from Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, on production of an official receipt for the sum of Three Guineas, which sum must be deposited with the Board's Accountant and will be returned on receipt of a bona fide Tender, together with all incidental papers. Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the "Metropolitan Water Board" and not to individuals.
Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, 173, Rosebery-avenue, E.C. 1," and endorsed "Tender for Boilers, Walton," must be delivered at the Offices of the Board not later than 10 a.m. on Monday, 12th November, 1923.
The Board do not bind themselves to accept the lowest or any Tender.
G. F. STRINGER,
Offices of the Board, Clerk of the Board.
173, Rosebery-avenue, E.C. 1,
3694 28th September, 1923.

SITUATIONS OPEN

WANTED by a London Firm, ENGINEER, Preferably member of Institution, with commercial experience and connection among rly. engineers, Govts Depts., and public works.—Address, with full particulars and salary required, 3734, The Engineer Office. 3734 A

WANTED, ENGINEER, Possessing British First-class motor ticket for Shop Work, as Assistant Tester.—Address, "TESTER," Wm. Porteous and Co., Advertising Agents, Glasgow. P8104 A

WANTED, ENGINEER SALESMAN, with Large experience Light Railway and Rolling Stock. State age, experience, education, languages, &c.—Address, 3736, The Engineer Office. 3736 A

WANTED, Expert WATER FILTRATION ENGINEER, preferably with both constructional and operative experience, for home and possibly colonial service. Good salary to the right man.—Address full particulars as to qualification and experience, 3714, The Engineer Office. 3714 A

ENGINEER WANTED for Design and Construction of Chemical Plant. State age and experience.—Address, 3735, The Engineer Office. 3735 A

GENERAL MANAGER WANTED by an Important Engineering Company in the North of England. Salary £2000 p.a.—Applications, which will be received as strictly confidential and which must give full particulars of experience and qualifications, are to be made to Box 98, Wheeler's Advertising Agency, Manchester. P8077 A

JUNIOR TECHNICAL ASSISTANT REQUIRED, with technical training to the standard of honours degree in engineering or science and preferably some works and aircraft experience. Salary £175-15-£235, plus cost of living bonus, which at current rate on £175 amounts to £97 a year.
Also TEST ASSISTANT, with technical training to the standard of pass degree engineering or science, with preferably some works experience. Wages 40s. to 80s. a week (according to qualifications), plus cost of living bonus, which at current rate on 40s. amounts to 28s. a week.
Apply, giving full particulars of experience, to SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants. 3742 A

REQUIRED by Manufacturers of Internal Combustion Engines, a qualified WORKS MANAGER. State age, salary and experience.—Address, 3699, The Engineer Office. 3699 A

REPRESENTATIVE REQUIRED, with Established connection London district, to obtain Engineers' Repetition Work for Manufacturers. Good commission basis.—Address, P8132, The Engineer Office. P8132 A

REQUIRED IMMEDIATELY for Sugar Factory, British West Indies, well-trained and thoroughly qualified ELECTRICAL ENGINEER for Installing and Operating Three-phase and Direct-current Plant. Salary £400 per annum with free quarters.—Write, stating age, training, and experience, to Box E. 450, c/o Dawson's, 121, Cannon-street, E.C. 4. 3741 A

SURVEYOR.—WANTED, Experienced SURVEYOR, used to Underground Work, to Survey Large Sewers in London.—Apply by letter, stating qualifications and salary required, to the CHIEF ENGINEER, London County Council, The Old County Hall, Spring-gardens, S.W. 1. 3712 A

TRAVELLER REQUIRED, for the Sale of Extruded Brass Rod, by one of the leading manufacturers. Must have first-class knowledge of the trade; none others need apply. State experience (fully) in confidence, age, and salary required.—Address, 3707, The Engineer Office. 3707 A

WORKS MANAGER REQUIRED for an Engineering Works with moderate output in South America, producing on repetition lines. A thorough knowledge of Foundry, Machining, Woodworking, and Drawing-office essential, and must have administrative ability. Age to be under 45 and single.—Write, A. H., c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 3726 A

WANTED AT ONCE, TWO or THREE DRAUGHTSMEN with actual workshop and detail design experience, preferably Conveying and Flour Milling Machinery. Juniors or improvers not required.—Address, 3755, The Engineer Office. 3755 A

WANTED, First-class GENERAL DRAUGHTSMAN, with knowledge of Steel Bridge Work and Constructional Design.—Address, 3747, The Engineer Office. 3747 A

WANTED IMMEDIATELY, Qualified LEADING DRAUGHTSMAN with experience Excavators, Steam and Electric Cranes, Haulage Gear, &c.—Address, stating age, wage, and experience, 3709, The Engineer Office. 3709 A

CAPABLE DRAUGHTSMAN WANTED for London Contractor's Office, experienced in design of Reinforced Concrete Work, including shuttering, layout of plant, &c.—State age, experience, and salary to Box 405, c/o Judd's, 81, Gresham-st., E.C. 3722 A

SITUATIONS OPEN (continued) Page 2.

SITUATIONS WANTED, Page 2.
PARTNERSHIPS, Page 2.
PATENTS, Page 2.
MACHINERY, &c., WANTED, Page 2.
FOR SALE, Pages 2, 3, 4 and 94.
AUCTIONS, Page 94.
PREMISES TO LET OR WANTED Page 3.
WORK WANTED, Page 3.
AGENCIES, Page 2.
MISCELLANEOUS, Page 2.

For Advertisement Rates see Page 369, Col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS, Page 93.

SITUATIONS OPEN (continued)

DRAUGHTSMAN, MECHANICAL, REQUIRED, with special experience of Mining Plant, Compressed Air, and Electrical Haulages. State experience, age, and salary required. Only experienced man need apply.—NORTONS (TIVIDALE), Ltd., Tipton. 3753 A

DRAUGHTSMAN REQUIRED by Aero Engineering Firm; must be experienced in Engine Installation. State age, experience, and salary required.—Reply, Box No. 77, G.P.O., Bristol. 3706 A

DRAUGHTSMAN REQUIRED for Jig and Tool Work, Aero Engineering Factory. State age, experience, and salary required.—Reply, Box No. 77, G.P.O., Bristol. 3706 A

DRAUGHTSMAN REQUIRED for Temporary Work on South Coast. Experience in Steel Structure Work and knowledge of Gasworks a recommendation. —Address, giving full experience, age, and salary required, P8116, The Engineer Office. P8116 A

DRAUGHTSMAN REQUIRED; Must Have Had extensive experience in Light Railway, Wagons, Points and Crossings, &c.; able to take out material and make up estimates, and design any necessary tools for the manufacture of new types.—Address, giving full experience, age, salary required, to W. G. BAGNALL, Ltd., Castle Engine Works, Stafford. 3720 A

DRAUGHTSMAN, Structural, Designer, Age About 30, works and office experience; able to prepare complete drawings and stress diagrams with a minimum of supervision, mathematics, theory of structure and earth pressure, and concrete foundations; knowledge of aerial ropeways an advantage.—Address, 3700, The Engineer Office. 3700 A

DRAUGHTSMAN, with Experience of Mechanical and Electrical Instrument Work, REQUIRED at Erith.—Apply by letter, stating age, experience, and salary, to Box No. 685, Advertising Offices, 84, Queen Victoria-street, London, E.C. 4. 3697 A

REQUIRED for Important Argentine Railway, a first-class RAILWAY CARRIAGE and WAGON DRAUGHTSMAN, age under 35; commencing salary £500 per annum on three years' contract; first-class passage provided.—Write, giving age and details training and experience, with copies (only) of any testimonials, to Box "C. and W.," c/o Davies and Co, 95, Bishopsgate, E.C. 2. 3721 A

SHIP DRAUGHTSMAN (HEAD) WANTED by Shipbuilder in Shanghai, aged 35 to 40. Must have held similar position before. Salary commencing £540.—Address, detailing experience, P8118, The Engineer Office. P8118 A

SITUATIONS WANTED

ADVERTISER (42), Life Experience Works Organisation, cost and production systems, stores control, general engineering, and mass production experiences, DESIRES POST as Works Accountant or Production Man or similar post.—Address, P8091, The Engineer Office. P8091 B

A.C.G.I. (35), Experience as Works Manager, Production engineer, D.O., steam pumps, air compressors, gearing, millwrighting, &c., served time in shipyard, DESIRES POST, home or abroad. Fluent German, some French.—Address, P8120, The Engineer Office. P8120 B

A.M.I.M.E. REQUIRES POST, Either in Works or offices; many years' experience as works manager of leading railway carriage and wagon works; fluent Spanish scholar.—Address, P8100, The Engineer Office. P8100 B

AN Experienced ENGINEER SEEKS SITUATION; good draughtsman, used to overhead conveying systems, interviewing, measuring up, &c.; excellent refs.—NEWTON, 5, Grosvenor-road, Ilford. P8099 B

APPOINTMENT DESIRED by ENGINEER, 26, (Millwright); French linguist, drawing-office, general factory maintenance, oil fuel. Now in foreign sales and publicity department of firm of agricultural engineers.—Address, P8121, The Engineer Office. P8121 B

CHIEF CHEMIST DESIRES POSITION; 24 Years in steel and motor works, sound experience ferrous and non-ferrous analysis, heat treatment and metallography.—Address, P8070, The Engineer Office. P8070 B

CIVIL ENGINEER, Age 39, Member Inst. M. and Cy. E., 18 years' Indian experience, roads, bridges, buildings, unable to live on furlough pay, WISHES TEMPORARY EMPLOYMENT, home or abroad, anywhere. Could represent buyers or manufacturers; well known Calcutta and industrial areas; able to secure business. Highest references, moderate salary and expenses.—Address, P8109, The Engineer Office. P8109 B

COMMERCIAL and TECHNICAL ENGINEER DESIRES responsible POSITION; age 44, wide general and structural experience. Specialities: mining, metallurgical, coke oven, plant and machinery, also all types of cranes. Successful salesman. Representative or commercial side preferred.—Address, P8105, The Engineer Office. P8105 B

ELECTRICAL ENGINEER, Luxemburgian, 25 years old, unmarried, specialist for h.t. and l.t. switch plants, SEEKS SITUATION. Two years with large Berlin electric company, first-class testimonials and references.—Address, P8097, The Engineer Office. P8097 B

ENGINEER (24), University Dip., Civil and Struct., 4 yrs. shops and D.O. exp., SEEKS APP., home or abroad.—Address, P8126, The Engineer Office. P8126 B

ENGINEER (30), Experience Locomotive and Railway work, D.O., design, estimates and specifications, wide technical knowledge, DESIRES POST, D.O. or works.—Address, P8112, The Engineer Office. P8112 B

ENGINEER (24) DESIRES POST, Assistant Works Engineer; sound training and good experience in all branches of engineering, D.O., construction, maintenance, gas producers, furnaces, glass, chem. works; used to control.—Address, P8088, The Engineer Office. P8088 B

ENGINEER, High-class Production, with D.O. and management experience, DESIRES POSITION on staff of established business. Invest £1/2000. No agents.—Address, P8114, The Engineer Office. P8114 B

ENGINEER, with Many Years' Steel Testing Experience in England, France, Belgium, fluent linguist, is free to UNDERTAKE INSPECTION WORK, SURVEYING, &c.—R. P., c/o W. H. Smith and Son, 11, High-street, Swansea. P8122 B

GENTLEMAN, Speaks French, with London Connection and knowledge of continental rolling mills and foundries, would ASSIST REPRESENTATIVE on commission.—Address, P8065, The Engineer Office. P8065 B

MECHANICAL ENGINEER (Aged 29), 13 Years' varied experience, 1st class technical education, SEEKS APPOINTMENT.—Address, P8123, The Engineer Office. P8123 B

MECHANICAL ENGINEER (30, Single) REQUIRES responsible POST at home or abroad. Sound theoretical and practical training, steam, I.C. engines, turbines, pumps, boilers, construction, running and maintenance, D.O.; 3 years' oilfield experience abroad.—E. S. N., "Chestnuts," Peakirk, Peterborough. P8125 B

SITUATIONS WANTED (continued)

MECHANICAL ENGINEER (29), M.A. (Hons.), Glasgow, 6 years' D.O. and shops training in Scottish tube works, held senior colonial appointment as assist. dist. eng. in Near East, DESIRES suitable POST at home or abroad; fluent German, highest references.—Address, P8096, The Engineer Office. P8096 B

OIL ENGINES.—ADVERTISER, with Exceptional experience in the design of semi-Diesel and other types, both two and four-cycle, for land and marine work, is OPEN for ENGAGEMENT with good-class firm; can give highest references.—Address, P8108, The Engineer Office. P8108 B

RAILWAYS, LIGHT, HEAVY.—ADVERTISER (37), wide experience, manufacture, consulting, designs, &c., WANTS POST any capacity; used to control, accustomed home, colonial and foreign works. —Address, P8110, The Engineer Office. P8110 B

STRUCTURAL STEEL WORK and REINFORCED CONCRETE ENGINEER, 25 years' experience, held responsible and managerial positions for past 15 years, OPEN similar ENGAGEMENT. Representative, or prepare estimates, designs, &c., for architects, engineers, builders, at moderate charges.—S.S. 363, c/o Deacon's, Leadenhall-street, E.C. 3. 3735 B

DRAUGHTSMAN (21) DESIRES SIT.; Five Years' shop and D.O. exp., well up in die casting, die design, also exp. on jigs and tools.—Address, P8128, The Engineer Office. P8128 B

DRAUGHTSMAN (26, Married), 7 Years' Shops and D.O. experience, steam and I.C. engines, SEEKS CHANGE. Moderate salary; London district preferred.—Address, P8107, The Engineer Office. P8107 B

DRAUGHTSMAN (32), Experienced Constructional steel work, steel-framed buildings, &c., details and design, DESIRES POSITION in London. Efficient and reliable.—Address, P8130, The Engineer Office. P8130 B

DRAUGHTSMAN, Leading, DISENGAGED; Wide experience in general engineering, machine design, electro-mechanical work; practical, progressive.—Address, P8124, The Engineer Office. P8124 B

LADY TRACER SEEKS POST in London; Six years' experience (structural and mechanical).—Full particulars.—Address, P8117, The Engineer Office. P8117 B

YOUNG MAN (25), University Trained, Sound Experience in foundry, machine and fitting shops, testing, cost office, D.O., &c., SEEKS a SITUATION in D.O. or workshops. Good references.—Address, P8111, The Engineer Office. P8111 B

SHOP FOREMAN (32) SEEKS RE-ENGAGEMENT; general production, engine, machine tools and maintenance; good refs.—Address, P8119, The Engineer Office. P8119 B

METAL BLASTER (21) SEEKS POSITION Abroad, oxy. hole boring and cutting; 3 years' experience; anything from 2 cwt. to 38 tons.—Address, P8109, The Engineer Office. P8106 B

MILLWRIGHT (40) SEEKS WORK in Country or small town; all-round mechanic, own tools, life abstainer, single.—Address, P8059, The Engineer Office. P8059 B

STOREKEEPER (Exp.) SEEKS an ENGAGEMENT; good organiser, not afraid of work and thoroughly conversant in all details of stores management.—Address, P8129, The Engineer Office. P8129 B

PARTNERSHIPS

PARTNERSHIPS ENGINEERING AND BUSINESSES.

Wheatley Kirk, Price & Co.
46, Watling Street, London, E.C. 4.

Established seventy years.

ENGINEER REQUIRED, with Motor Experience, in old-estab. motor business, Home County; good agencies, audited accounts, turnover £9000 p.a.; £1500 required for half share, return £500 p.a.—ARNOLD and CO., 149, Cannon-street, E.C. 3740 C

PARTNERSHIPS and ACTIVE DIRECTORSHIPS WANTED in Mechanical, Constructional, Electrical Engineers, &c., for Clients with technical experience and capital from £1000 to £30,000.—GILBERT and PRATT, 18, Walbrook, London, E.C. 4. Ex. C

PROFESSIONAL GENTLEMEN REQUIRING EXTRA CAPITAL in their businesses, or SLEEPING PARTNERS, and whose books will stand every investigation, are invited to communicate with Messrs. AUSTIN, 30, Maddox-street, W. 1. 3711 C

UNIVERSITY GRADUATE QUALIFIED ENGINEER; wide experience of transport problems with railway and motor experience, REQUIRES DIRECTORSHIP (active). Ex-officer and late Government official.—Box "L.," c/o Geo. Kelly and Co., 14, Victoria-street, S.W. 1. 3739 C

AGENCIES

COMMERCIAL ENGINEERS, Exporting Through London merchants to China, Burmah, India, Africa, and West Indies, &c., have excellent opportunity to offer additional Constructional Engineering and Building Materials, especially Constructional Steel. Correspondence direct with manufacturers would be welcomed.—Address, 3607, The Engineer Office. 3607 D

ENGINEER REPRESENTATIVE, Representing in Midland Counties a well-known firm, DESIRES CHANGE. Experienced, educated, energetic, good connection. Accept moderate salary from firm of repute.—Address, P8131, The Engineer Office. P8131 D

TRADE WITH INDIA.—ENGLISHMAN (35), Government official in India, now London on leave, PREFERS COMMERCIAL CAREER; 15 years' connection trade and industry in India. Acclimatised, thorough knowledge people, language, and local conditions. Would manage branch or travel. Interview. —Address, P8098, The Engineer Office. P8098 D

WE Are DESIROUS of APPOINTING SOLE DISTRICT AGENTS covering the British Isles, for the sale of a new Electric Arc Welding Plant and Accessories. Only applications from well-established firms will be considered.—COWAN and FOX, 25/27, Dickinson-street, Manchester. 3751 D

WELL-KNOWN CONTINENTAL ENGINEERING FIRM, with London office, specialising in turbines, turbo-blowers, compressors, pumps, &c., WISHES to APPOINT influential and experienced AGENT for Glasgow district. Write fully in the first instance, stating experience and past and present activities.—Address, 3733, The Engineer Office. 3733 D

WORLD TRAVELLER, Representing Important British engineering manufacturers in five continents, is OPEN to REPRESENT MANUFACTURE of any class of Machinery except power plant.—Address, P8012, The Engineer Office. P8012 D

MISCELLANEOUS

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For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

Commercial Aeroplanes.

A striking feature of the trials of commercial aeroplanes carried out at Le Bourget by the French Ministry of Aviation was the success of the thick-section monoplane wing, which has proved as satisfactory for the heavy machines as for the lighter. Qualifying tests were of a severe character, and comprised horizontal gliding after stopping the engines, the cutting out of an engine and the replacing of sparking plugs during flight, a maximum distance for rising from the ground, and the carrying out of other conditions to ensure that the machines possessed the required margin of safety and handiness of control for passenger traffic. The machines were then sent on journeys between Paris and Metz until they had accomplished a distance of 3000 kiloms., with intermediate landings. The classification was based upon the coefficient of load and speed divided by the petrol consumption. The first award was made to the Farman monoplane, the Farman Goliath being second, and the Bleriot biplane third. The Farman monoplane was fitted with four Hispano-Suiza engines, each of 180 horse-power, and the Goliath had four Salmson engines of 260 horse-power. The load of the former was 800 kilos., as compared with 600 kilos. for the Goliath. The length of the Farman monoplane was 14 m. and the width 19 m. It had 81 square metres of lifting surface, and the weight was about 3 tons. The success of the Farman machine appears to have demonstrated once more the high efficiency of the thick-section monoplane wing, which not only permits of a curvature providing a depression on the upper surface, that increases the lifting power, but also diminishes resistance by the partial or entire suppression of struts and stays.

The Institute of Transport.

The first ordinary meeting for the 1923–24 session of the Institute of Transport was held on Monday evening last, when, after the announcement as to the officers and Council had been made and the premiums for papers read during the last session presented, the new President, Sir Joseph G. Broodbank took the chair. It may here be noted that Mr. H. E. Blain has retired from the office of hon. secretary, and Mr. A. Winter Gray succeeds him as from the 1st inst. Sir Joseph, in his presidential address, dealt with "The Ideal Sea Port," of which a summary of the engineering features appears on a subsequent page. He discussed such subjects as the situation of ports—which may be inland as long as there is accessibility to the sea—port facilities, concentration of accommodation, size of docks, straight quays—the importance of which is not recognised by all engineers—cranes and conveyors, cargo sheds and warehouses. Whilst the new President dealt mainly with the Port of London, as being identified therewith, his remarks covered other places, and where differences in practice occurred, explanations for them were often given. The address also made mention of management, rates and charges, staff and labour.

Rebate for Privately Owned High-Capacity Wagons.

It is announced that the Great Western Railway Company is prepared at once to allow a rebate of 5 per cent. off the rates in respect to coal traffic conveyed wholly over its system in fully loaded privately owned wagons. This offer is made with the view to produce those economies—less dead weight, shorter trains, less standing room required when running and in sidings—that would come from the substitution of 20-tons wagons for those with 10 tons or 12 tons capacity. The Great Western differs from the systems formerly known as the Midland, North-Eastern, Caledonian and North British, in that it relies entirely upon the colliery proprietor, coal factor or merchant to provide his own wagons for the conveyance of coal. That branch of the Statistical Department of the Board of Trade which used to deal with the annual reports and returns of the railway companies took a census as on August 1st, 1918, of the capacity and structural details of all the privately owned wagons. This survey showed that out of 530,417 open wagons owned by persons engaged in producing or selling coal, 771 had a capacity of under 8 tons, 96,164 of from 8 to under 10 tons, 329,257 of from 10 to under 12 tons, 99,889 of from 12 to under 15 tons, and 4336 of over 15 tons capacity.

The Future of Dover Harbour.

The Admiralty Harbour at Dover, completed fourteen years ago at a cost of some five million pounds, was handed over on Saturday to the Dover Harbour Board for use and development for commercial purposes. As a naval base, Dover will now cease to exist, except in so far as it will provide accommodation for a few submarines, but from the commercial point of view, largely in connection with the landing and storage of oil, it is believed that when the developments contemplated are complete, it will be one of the finest harbours round the coast. It is proposed to expend a sum of one and a-quarter million pounds on the adaptation of the existing harbour works wholly to commercial ends.

International Seaplane Race.

Victory in the Schneider Cup Seaplane Race at Cowes last Friday went to America, the contest being won by Lieut. Rittenhouse on a Curtiss naval racing seaplane fitted with a 465 horse-power Curtiss engine. A second Curtiss machine, also belonging to the United States Navy, came in second, while the sole British competitor, Captain Biard on the Supermarine flying boat, occupied third place. The contest was carried out in calm weather, a fact which probably favoured the Americans in the preliminary seaworthiness tests, for in anything like rough water their float type of machines could not have given as good an account of themselves as the British and French machines, which were all of the flying boat type. The winner completed the course of 212 miles in 1 hour 12 min. 26.8 sec., showing an average speed of 177.38 miles an hour. The second Curtiss flew at an average speed of 173.46 miles per hour, and the Supermarine at 157.16 miles. These three machines alone completed the course, although six all told started. The Blackburn "Pellet" flying boat met with disaster during the preliminary taxi-ing tests, the pilot by great good fortune escaping alive. The result of the contest cannot be described otherwise than as an American triumph, for the winner's speed is truly remarkable for a seaplane, comparing, as it does, with 140 miles an hour, the record established a year ago by Captain Biard when he won the Cup at Naples.

The Southampton Dock Extension Scheme.

As a consequence of a conference between representatives of the Southern Railway and of Southampton Corporation definite steps in advance appear to have been taken in connection with the proposed scheme for extending the dock and conjugate facilities at Southampton. Besides a large increase of dock accommodation the scheme includes the enlargement of the West Station to twice its present size and the remodelling of the Town Station, the construction of a bridge in place of an existing level crossing, and the addition of a large number of rooms to the South-Western Hotel. It is said that the Corporation and the railway will almost certainly come to agreement over the scheme in the immediate future. In that event the railway intends, we learn, to deposit a Bill in Parliament in November, and it is hoped that with the Royal Assent secured work on the scheme may be begun next summer.

The International Sleeping Car Company.

Some time ago the board of directors of the International Wagons-Lits Company aroused much opposition among the company's shareholders by proposing to place an order for new cars in this country, payment to be made by the issue to the builders of 31,000 fresh shares. Last Saturday the shareholders discussed the matter at great length at a meeting at Brussels, and by an overwhelming majority marked their sense of disapproval by approving a motion to withdraw the mandates of the board of directors. A new board of seventeen directors, including Sir D. Dalziel and Mr. F. H. Houlder, was elected. The new board has, we gather, agreed to carry out the wishes of the shareholders by placing the orders for the new rolling stock in France and Belgium, by making cash payment for it, and by raising the necessary money by offering the new shares to the old shareholders.

The Barking Super-Power Station.

Work on the new super-power station at Barking of the County of London Electric Supply Company is making good progress. The foundations have been practically completed by the contractors, the Consolidated Construction Company, Limited, of London, the orders for the generators, boilers, switchgear, &c., have been placed, and during the past few days the Consolidated Construction Company has received a contract valued at some £80,000 for the erection of the buildings. The engine-room, we understand, will measure 296ft. by 100ft., the transformer house 296ft. by 20ft., and the boiler-house 255ft. by 126ft. In order to carry the cables from the station to the South London area a tunnel 7ft. in diameter is to be driven beneath the Thames, and tenders for the execution of this portion of the work are now being invited. The total cost of the new station will be somewhere in the neighbourhood of two million pounds.

A Record Airship Flight.

On the morning of September 25th the French airship Dixmude—one of the Zeppelins surrendered by Germany under the terms of the Peace Treaty—left Toulon for a duration trial. Crossing the Mediterranean, it flew over Algiers, passed eastwards along the African coast to Bizerta and Gabes, and then proceeded inland across Algeria to the Moroccan boundary. Thereafter it returned to Bizerta, intending to make for Europe by way of Sardinia, but bad weather being encountered it returned to the African coast and subsequently proceeded to Marseilles by way of Sicily and Corsica. From Marseilles it flew to Bordeaux and Paris before returning to its base at Toulon, which it reached in the early hours of the 30th. During the whole of its journey, a matter of some 4400 miles, the airship did not make a single stop. It was in the air for 118 hours 41 minutes. In so doing it surpassed the previous record airship flight, that of a Zeppelin, which in 1917 flew from Bulgaria to Khartoum and back in a fruitless endeavour to convey succour to the German troops in East Africa. The Transatlantic voyage of the British airship R 34 from Edinburgh (East Fortune) to New York in 1919 occupied 108 hours 12 minutes, but from its nature and from the fact that the return voyage was successfully accomplished within the next few days it must still, we think, be regarded as the premier airship performance, although it now occupies but third place in the matter of actual non-stop duration.

The Boilermakers' Dispute.

At the moment of writing the position of matters in the boilermakers' dispute is very fluid. On Friday of last week representatives of the employers and of the Federation of Engineering and Shipbuilding Trades met at Carlisle as arranged. The outcome of the meeting was a clear pronouncement on the part of the Federation that the Boilermakers' Society was not expelled from the Federation until May 17th, and was therefore bound by the overtime and night-shift agreement which the Federation signed on behalf of all its members on March 22nd, 1923—a pronouncement wholly supporting the employers' contention. On the employers' side the conference made it clear that they were prepared to give, in the application of the provisions of the agreement, due consideration to special circumstances peculiar to any trade, including that of the boilermakers. Together the Federation and the employers rejected the proposal that the dispute should be submitted to arbitration or a court of inquiry. On Monday a further step towards clearing up the situation was taken by the General Council of the Trades Union Congress. That body, no doubt alarmed by the great harm being done by the dispute among the unions not directly concerned in it, took steps to call a conference between its representatives and those of the Boilermakers' Society and the Federated Trades. The meeting took place on Monday in London, but after prolonged discussion no announcement was made as to the progress made.

The Naval Torpedo School.

For the past fifty years, ever, in fact, since its origination in 1872, the Naval Torpedo School at Portsmouth has had its quarters in hulks, of which the Vernon, a frigate launched in 1832, was perhaps the best known in view of the fact that it gave its name to the whole establishment. The School is now in process of being transferred to new and permanent quarters ashore, comprising works and buildings on which over £650,000 have been spent since 1920. The Vernon has just been sold, and of the other hulks, the Marlborough and Donegal, line-of-battleships, launched in 1855 and 1858 respectively, have been placed on the sale list, while the Warrior, our first iron armoured ship, launched in 1860, is being retained for the time being. These old vessels had fallen into a bad state of repair and were unfit to remain much longer at their moorings. The erection of the shore establishment was therefore proceeded with as quickly as possible, and although the works will not be completely finished until early next year, the greater part of the School was transferred to its shore quarters on Monday. The new establishment will serve as a centre for everything to do with the electrical branch of the service, mining, anti-mining, and torpedo work.

The Largest P. and O. Liner.

To-day (Friday) there sails from Tilbury on her maiden voyage to Bombay the ss. Mooltan, the largest liner of the Peninsular and Oriental Steam Navigation Company. This is the third steamer owned by the company to bear the name. The first Mooltan was built in 1860 and had a Customs measurement of 2257 tons and engines of 400 horse-power; while the second was a passenger liner of 10,000 tons register, built by Caird and Co., of Greenock, with engines of 12,000 indicated horse-power and a length of 540ft. The new Mooltan was built by Harland and Wolff, of Belfast, and is 625ft. in length, 73ft. in breadth, and 44ft. in depth. Her gross tonnage is about 20,800 tons, and her twin-screw quadruple-expansion engines have been designed to develop about 15,500 indicated horse-power, corresponding to a mean service speed of about 16 knots. A brief account of the ship, her accommodation, and her propelling and auxiliary machinery was given in our issue of last week. She is noteworthy as being the largest passenger liner built for the Suez Canal service, and among her many electrical appliances is a 20in. searchlight of the Parsons split mirror type, an arrangement which permits of both banks of the canal being illuminated by the one searchlight.

Science and Industry in America.

By WALTER ROSENHAIN, D.Sc., F.R.S.

No. IV.*

THE AUTOMOBILE INDUSTRY.

Reference has already been made in various connections to the use of scientific methods when dealing with motor car production; such references are unavoidable in dealing with the application of science to the industries of a country in which the motor car plays so very large a part. The huge development of this industry is well known; it can be readily appreciated from the roughest figures, viz., that at the beginning of the present year there were over eleven million automobiles, including over three million Ford cars, on American roads, for a population not very much over 100 millions. With a home market of these dimensions the industry has developed under exceptionally favoured conditions. From the point of view of the application of science and scientific methods to this work, reference need only be made to two of the largest and most typical cases. The Ford Motor Company uses every scientific resource which is available and has large and really well-equipped laboratories, both chemical, metallurgical and physical testing. So far as it was possible to judge, however, from a necessarily brief inspection of so enormous a plant, there seems to be little or no effort at anything like real research. To judge from the spirit which animates these works, rather than from anything that was actually said, it would seem that there was very little sympathy or desire for research for making any special advances in this plant; there is, however, a keen watchfulness for results obtained elsewhere and for immediately testing their applicability to the special needs of Ford motors. The presiding and altogether predominating genius of Henry Ford himself does not show any sympathy for research as such; his well-known opposition to anything bearing the slightest touch of the academic does not make him a friend or supporter of real research, whether within his works or without. Practical advances and discoveries are the object of interest to Ford Motors, and to this extent that great concern can only be regarded as being parasitical upon the scientific efforts of others. This is, of course, a very special case of an industry developed upon novel lines, and it is not the writer's desire in any way to sit in judgment upon it. Yet any industry which does not bear its proper share in furthering the advancement of the sciences upon which it is in reality based cannot be permanently stable, a fact which many other industries are steadily coming to recognise. From the scientific point of view it can only be deplored that the genius which has built up the Ford organisation fails to recognise the indebtedness to science, which in reality exists at every turn of those great works. If that relationship were properly appreciated the resources and organising powers of Henry Ford might have given America a centre of scientific research in connection with the automobile and allied matters equal to those which the great electrical industries have established.

It is interesting to find that another great American motor car producing organisation, the General Motors Corporation, has very fully recognised the need for research in direct bearing upon that industry, and has established, under the name of the "General Motors Research Corporation," at Dayton, Ohio, a group of research laboratories comparable with the finest research establishments in the world. The laboratories are under the control of this Research Corporation, which is a subsidiary company of General Motors, and are situated in the country a few miles outside the town of Dayton, not far from the aerodromes of the Wilbur Wright Field and of McCook's Field, the United States equivalent of our Royal Aircraft Establishment at Farnborough. Externally, the laboratory buildings have the appearance of a large factory, built mainly on a single floor, and so arranged that full-size motor cars, when required for experimental purposes, can be brought along the main corridors and into or alongside any desired laboratory. This large establishment includes experimental workshops as well as laboratories proper.

In speaking of a large organisation devoted entirely to research and experimental production it is not easy to select matters of special interest or to convey any adequate impression of the range of work covered without giving a lengthy description. One or two matters only can be mentioned by way of example. Perhaps one of the best-known products of this research establishment is the discovery of the so-called anti-knock compounds. It is well known that when the compression ratio of an internal combustion engine is too high, whether as a result of design or of subsequent restriction by carbonisation, the engine "knocks," *i.e.*, pre-ignition of the charge occurs and the power and efficiency of the engine fall off rapidly. It is also well known that the nature of the fuel used in the engine has a considerable effect and that the use of benzol very considerably lessens the tendency to "knock." It has been discovered at Dayton, as the result of systematic research, that certain substances have the power of thus preventing or retarding "knocking" even when present only in minute proportions. Their action might be described, for want of a better term, as "anti-catalytic," in the sense that their presence, by a mechanism which is not yet understood, hinders the occurrence of the chemical combination which constitutes combustion or explosion. Iodine has this property to a considerable extent, but unfortunately iodine is not soluble in ordinary motor fuels such as petrol, and is therefore not readily introduced. One of the compounds discovered at Dayton which exhibit this property in a very marked degree is "tetra-ethyl-lead," but this substance is excessively poisonous and thereby unsuited for general use. In other cases, including particularly certain compounds of tellurium, the resulting odour of the exhaust gases is so objectionable that their use could not be tolerated, while others again give rise to seriously poisonous fumes. It is thus an important object for further research to find less objectionable substances which possess this valuable property. The importance of the discovery, whose ultimate practical applicability can scarcely be doubted, lies in the fact that the use of such anti-knock agents will allow engines to work with considerably increased compression ratios and a correspondingly greater efficiency and greater power output per unit of cylinder volume.

Another very interesting product which has been developed by researches on somewhat parallel lines in the Dayton laboratories of General Motors and in the Schenectady laboratories of the General Electric Company is a new type of bearing metal. This is literally a spongy material which has all the appearance of a bronze-like metal. It is prepared in various ways, one being to make a mixture in a very finely powdered state of copper, tin and graphite. This is pressed into moulds of the shape desired for bearing bushes and is then heated. The graphite burns out, leaving a finely porous mass, the two metals uniting to form a solid alloy. This porous metal can absorb a large quantity of lubricating oil—it is almost as absorbent to ordinary liquids as blotting paper—and thus serves as a reservoir of lubrication which lasts without further attention for a very long time. As yet the mechanical strength of the porous metal is not great enough to allow it to be used for bearings carrying heavy loads or exposed to serious shock, but for lighter work it is proving extremely useful. It is a method of meeting the demands of bearing construction which is certainly novel, and it may well lead ultimately to a revolution of practice in this respect.

ELECTRICAL INDUSTRIES.

It is an interesting and significant fact that the largest of American research laboratories are maintained by three great electrical corporations—the General Electric Company, the Western Electric Company, and the Westinghouse Company. American opinion seemed to ascribe this fact mainly to the enormous development of electrical industry in America, so that these great corporations are well able to support such large-scale research establishments. While this is undeniably true, the fact remains that other very large American industries, notably the metallurgical, are also well able to afford such establishments, yet make no attempt of that kind. Other factors must therefore be operative, and these are probably to be found in the origins of the different industries. Modern metallurgical industry has grown up out of rule-of-thumb practice, upon which scientific control and research methods have only been grafted with some difficulty and to an, as yet, entirely inadequate extent. The electrical industries, on the other hand, have originated from a great scientific discovery and have progressed by the aid of a series of further scientific discoveries and researches. It is not, therefore, as surprising as might at first sight appear that the electrical industry is more ready than most others to recognise to the full the value of scientific research from the industrial point of view and to recognise, not only this value, but the true nature of research and the conditions of free development under which alone its best fruit can mature. Industrially controlled research is, in most cases, invited to produce results of direct and immediate practical value; it is expected that a definite return can be indicated in advance for every line of work undertaken. Thus in one large American concern which prides itself on an extensive research laboratory, it is a rule that before any piece of work is begun a form shall be filled up showing the probable saving or gain to the company which is to be attained if the work is successfully carried out. The stultifying effect of such a regulation, even if widely or loosely interpreted, is very great, since it has the inevitable effect of keeping the minds of investigators altogether too closely chained to the present processes and interests of the company, yet these may be entirely different from the real future interest at stake. The matter has been very tersely put by an American who has recognised this aspect of research, and it might well serve as a motto for the guidance of those responsible for industrial research:—"If we had confined our attention to the improvement of candles we should never have had electric light." Manufacturers are only too apt, all over the world, to endeavour to keep the minds of their "research" staff concentrated on the improvement of the particular brand of "candle" which they are at the time turning out.

The great research laboratory of the General Electric Company at Schenectady, New York, is therefore the more interesting as it is a striking example of an application of the broadest spirit to the problems of industrial research. The scope and scale of this laboratory is indicated best, perhaps, by the well-known names of the men of science who constitute its senior staff. Names such as Langmuir, Coolidge, Hull, Steinmetz, Dushman carry their own message; most of these names are familiar to the readers of scientific literature, to many of whom the fact that these men are in the service of the American General Electric Company is unknown. The director of the laboratory, Dr. Whitney, is not, perhaps, so widely known for his personal published researches, but his personality and influence are very real factors at Schenectady. At the time of the writer's visit to the G.E.C. laboratory Dr. Whitney was unfortunately absent in Europe; none the less, the whole establishment spoke of his influence, so much so that it was repeatedly said that the "G.E.C. laboratory IS Dr. Whitney." The spirit of solidarity, of comradeship and close friendly co-operation which was evident at Schenectady was a most striking feature. Incidentally it was the only place in America where the writer's own views received a really critical attack, a mode of treatment which he very much appreciated.

The work of the G.E.C. laboratory covers so wide a range that it is impossible to deal even briefly with more than a few examples selected more or less at random. Perhaps the most striking activity is that connected with what we call "wireless," but is known in America as "radio." Being almost entirely unfettered by any governmental restrictions, this industry, in connection with broadcasting, has assumed immense proportions. While this has, no doubt, proved an excellent source of business to the industry, it is far from being an unmixed blessing to the "listener in," as there is a very serious amount of interference of all sorts, both from more or less authorised transmitting stations and from the "reactance" or "regenerative" sets of near-by amateurs. The problem of highly accurate tuning, both for transmission and reception, thus becomes a matter of first-rate importance. On the other hand, the development of high-power transmitting apparatus is also a matter which is being most actively pursued, particularly in relation to the production of transmitting "valves" for very high powers. These valves, the varieties of which are called by a series of bewildering special names, such as "kenotron," "pleiotron," &c., have received immense development in the G.E.C. and other American research laboratories, where attention has been concentrated upon high-power tubes made of metal and water cooled where necessary. These tubes are relatively very small for the power they can transmit, but although not very much is yet known of their permanence, they are obviously much less fragile than those made of glass. A very large example of these transmission valves was shown to the writer at Schenectady; it was expected to transmit 1000 kilowatts and had as primary filament a solid rod of tungsten some 5 mm. or 6 mm. thick, carrying a current of 3000 ampères.

TUNGSTEN.

The mention of a tungsten "filament" of this size naturally leads to that side of the Schenectady laboratory dealing with the production of drawn tungsten wire, a process originated by Dr. Coolidge. This process is carried on here on a large laboratory or a small works scale, although the greater part of the tungsten wire manufacturing process is now carried out in the G.E.C.'s works at Cleveland under the direction of Dr. Z. Jeffries. The processes of tungsten manufacture are too well known to require description, but it is none the less an impressive operation to witness. Furnaces working regularly with an internal atmosphere of hydrogen are, in themselves, no mean achievement. At the present time, however, when a fairly cheap supply of helium gas is available in America, it would almost seem worth while to replace, wherever possible, an inflammable and explosive gas like hydrogen by one that is completely inert. Helium could probably be used in much smaller quantities than hydrogen, since the latter must be supplied fast enough to burn freely at the mouth of the furnace without risk of "lighting back." With helium there would be no need to combat flame velocities, and the more costly gas might even be more or less completely recovered. That, however, is a problem which the Schenectady laboratory could very readily work out; it is mentioned here as a passing suggestion.

The problem of actually melting and possibly casting tungsten has not yet been solved, even if it has been attacked. The real difficulty which stands in the way is, of course, not the exceedingly high temperature required, but the fact that there is no known material which could hold liquid tungsten, with the possible exception of carbon under very high pressures, and then it would be impossible to prevent the formation of carbides. Whether the metal could not be melted in a cooled bed of its own powder yet remains to be seen; so far even Schenectady, with its very great resources in that direction, has not yet achieved the result. On the other hand, work is in hand for the application of exceedingly high temperatures to tungsten wires by means of the explosive discharge, through a fine wire, of a large

* No. III. appeared September 28th.

charge from a battery of condensers. This experiment of exploding a fine tungsten wire by means of a condenser discharge has, of course, been carried out elsewhere in America and some very remarkable results have been claimed, no less, indeed, than the disintegration of the tungsten atom with the formation of helium gas. The most experienced men at Schenectady do not accept the latter result as even approximately established; it is a result which, on the basis of our present knowledge of atomic structure and atomic behaviour, does not appear at all probable, and in practice it is almost impossible to be sure that the helium found in such an experiment after the explosion is really derived from the tungsten. None the less, these experiments are regarded as of very great interest. In the first place, they make it possible to reproduce in the laboratory a range of extremely high temperatures, running up, it is estimated, to beyond 30,000 deg. Cent., which we have hitherto been able to study only in connection with the spectra of the hottest stars; they are, of course, temperatures far exceeding those of the sun. The behaviour of matter at such enormous temperatures, particularly in regard to the spectra emitted, is a matter of the greatest abstract scientific interest. On that ground alone the research workers at Schenectady are free to utilise immense laboratory resources to pursue the matter. Yet—and no doubt this is fundamentally at the basis of this broad policy—it is by no means certain that sooner or later some practical application may not arise in which these extreme temperatures, or at least the knowledge of matter derivable from the experiments in question, will play a fundamental part. No one can see beforehand where such researches will lead, but past experience amply justifies a broad policy. A number of such fields of inquiry may be drawn blank so far as direct industrial results are concerned, but results are apt to accrue in the least expected direction.

Although much of the actual research and the manufacture based upon it is carried out at Cleveland, yet the whole subject of tungsten wire for lamp filaments is so intimately associated with the General Electric Company and the work of Schenectady itself that further mention of it at this point seems appropriate. The story of tungsten wire and the difficulties connected with its use at the very high temperatures which occur in incandescent lamps is so well known that it need not be repeated here in detail. Briefly, however, it may be recalled that in some respects the behaviour of tungsten presents what is, at first sight, a metallurgical anomaly. When the metal, after sintering and swaging, has been drawn down into wire it is comparatively ductile; the drawn wire can be bent and coiled without difficulty, although there is always a considerable tendency for the wire to split longitudinally. In other metals no tendency to longitudinal splitting is, as a rule, encountered; but, on the other hand, drawing them into wire in the cold tends to destroy rather than to improve their ductility. Further, when tungsten wire is heated to any considerable temperature, not necessarily as high as that used in electric lamp bulbs, and is then cooled down again, whether this has been done in vacuo or in hydrogen or other neutral atmosphere, the wire becomes completely brittle, the least attempt to bend or coil it resulting in fracture, and this fracture is intercrystalline in character. Here, again, is a striking contrast to the behaviour of other metals, which are rendered soft and ductile by heating or annealing, particularly in a neutral atmosphere. The explanation for these and many other complex phenomena connected with the behaviour of tungsten wire has been given very clearly by Dr. Z. Jeffries on the basis of what is known as the "amorphous cement theory," according to which there is a thin amorphous or non-crystalline layer between adjacent crystals in every, even the purest, metal. This theory, it may be pointed out, originated in England, and is to some extent still a matter of controversy among British metallurgists. In America it seems to have found very ready acceptance and wide application; Dr. Jeffries went so far as to say that, without the aid of this theory and the guidance which it offered, the production of the modern tungsten wire lamp would not have been possible.

The fundamental postulate of the amorphous cement theory is that the intercrystalline layer, consisting of largely non-oriented atoms, is not capable of plastic deformation by the ordinary process of slip on crystal planes, but is capable of something in the nature of viscous or visco-elastic flow, and that the mobility—always very slight in the harder metals—diminishes with falling temperature, being really great only near the melting point and becoming very small indeed at temperatures very far removed from the melting point. According to Dr. Jeffries' view, the cold-drawn tungsten wire consists of greatly elongated crystals dovetailed into one another in such a way that substantially all the crystal boundaries are approximately parallel to the length of the wire. Coiling or bending such a wire therefore puts nothing but a slight shearing stress on the intercrystalline layers. After annealing, on the other hand, the crystals have become approximately equi-axed and there are numerous crystal boundaries and, consequently, intercrystal layers running across the wire. The same applies, of course, to wires of other metals, such as copper or iron, but with this difference that, in Dr. Jeffries' view, the amorphous material between the crystals of iron or copper, at a temperature some 1500 deg. or 1000 deg. Cent. respectively below their melting points, is still sufficiently mobile to allow of accommodation to the ductile yielding of the crystals, even when the boundary layers run across the wire. In tungsten, on the other hand, the amorphous layers existing at a temperature something like 3000 deg. Cent. below the melting point have lost even this small amount of mobility and have become completely rigid, so that, if forcibly deformed, they simply break and give the metal a completely brittle intercrystalline fracture. In support of this view he quotes the fact that iron at very low temperatures (— 200 deg. Cent.) exhibits the same intercrystalline brittleness as tungsten, while, on the other hand, tungsten in the neighbourhood of 1500 deg. Cent. is ductile and can be readily worked, although recrystallisation or annealing does not occur until much higher temperatures are reached, so that for this remarkable metal working at 1500 deg. Cent. is essentially "cold" working. Explanations of this type have been extended to the explanation and successful prevention of such phenomena as "off-setting" in lamp filaments, the effect of the presence of thoria, &c. From the present point of view the importance of this whole matter, however, lies in the fact that a theory at first looked upon as entirely of academic interest, and to which in the opinion of some "practical" metallurgists far too much attention has been devoted, has proved of the greatest practical value—once again, not in the country of its origin.

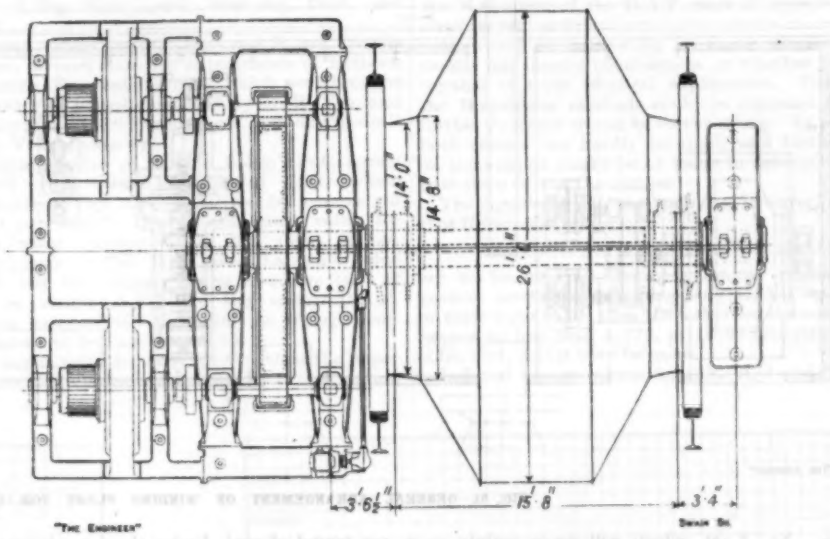


FIG. 58—ARRANGEMENT OF WINDING PLANT FOR HARWORTH MAIN COLLIERY

Electricity in Mines.

No. X.*

IN our first article of this series we referred to the S.P. winding system developed by the Metropolitan-Vickers Electrical Company. An interesting plant of this description has been built for the Harworth Main Colliery, where the winding conditions are exceptional,

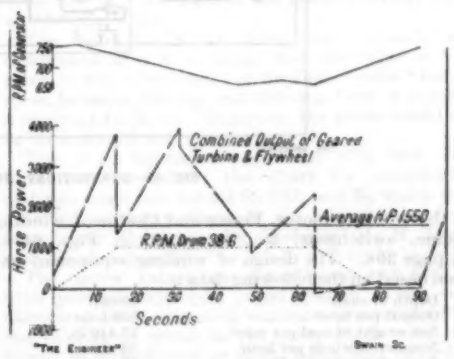


FIG. 59

the depth of the shaft being 3000ft. and the amount of coal to be dealt with 2000 tons per shift from either of two shafts. The winding programme is as follows:—

Depth of shaft	3000ft.
Output per hour	300 tons
Net load of coal	7½ tons
Weight of cage and chains	10 tons
Number of tubs per cage	9
Weight of empty tubs	7¼ cwt.
Rope diameter	2¼in.
Rope weight per foot	10.8 lb.
Decking time	10 sec.

* No. IX. appeared September 21st.

Coal is wound during the first two shifts, whilst the third shift is devoted to inspection, repairs, &c. Each shift is of 7 hours' duration, and 20 minutes are allowed for snap time, thus having 6 hours 40 minutes for coal winding.

Horse-power time diagrams are given in Figs. 59 and 60, the former relating to coal hoisting under normal conditions, whilst the latter is a combination of two diagrams, one showing the power requirements when lowering men and the other the power when hoisting and lowering men simultaneously. The full lines relate to raising men, the chain lines to raising and lowering men simultaneously, and the dotted lines to lowering men. The drawing, Fig. 58, gives the approximate dimensions of the drum, which is designed for use in connection with this equipment. The small diameter, it will be seen, is 14ft., and the large diameter 26ft. Advantage has been taken of the fact that the drum diameter may be reduced to smaller limits than is possible with a steam winder, thus lowering the torque and raising the speed for a given load and output. This reduces the initial cost of the equipment and increases its efficiency. The drawing, Fig. 61, shows the arrangement of the winding plant and the generating plant about the colliery. The drum is driven by two direct-current 1200 horse-power motors running at a speed of 350 revolutions per minute, and they are coupled through double helical reduction gears having a ratio of 9.15 to 1. These winding motors are capable of developing a maximum output of 6000 horse-power, and they are supplied with power from a turbo-generator equipment consisting of a 11,000-kilowatt high-pressure turbine with double helical gears, two 875-kilowatt direct-current variable voltage

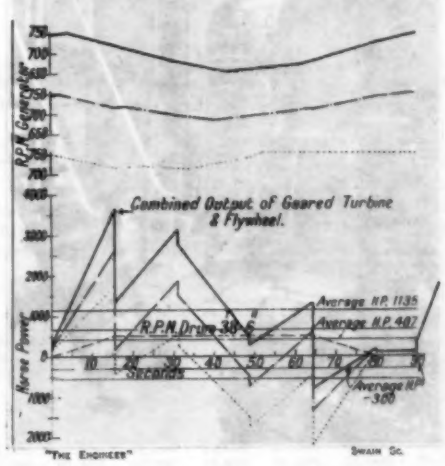


FIG. 60

generators, a 22-ton fly-wheel and an eddy current brake.

The turbine governor is designed to give a 15 per cent. drop in speed so as to allow the fly-wheel to give up its stored energy under peak load conditions. When regenerative braking is required in addition to the energy necessary to return the turbo-generator equipment to normal speed, the eddy current brake is automatically applied, and is designed to absorb all regenerative energy which would otherwise raise the turbine speed above the predetermined value. These conditions, however, only apply when an unbalanced load is being lowered into the pit. With this arrangement all the desirable features of an ordinary Ward-Leonard equipment operating from a large capacity power plant have been maintained. The power required for ventilating, haulages,

screens, &c., will be supplied by two 1500-kilowatt generators, whilst the excitation for the winding motors, generators and eddy current brake will be supplied by separately driven exciter sets. The scheme is particularly adapted for the economical development of the new sinkings, and in selecting the S.P. system the progressive power requirements of the pit have been considered and divided into three stages. It has been assumed that for some years coal will be wound from No. 1 pit only, and that No. 2 pit will be used as a standby and for occasional winds.

In the first stage it is proposed to equip No. 1 pit with one set of mechanical parts, comprising one drum with reduction gears and two 1200 horse-power

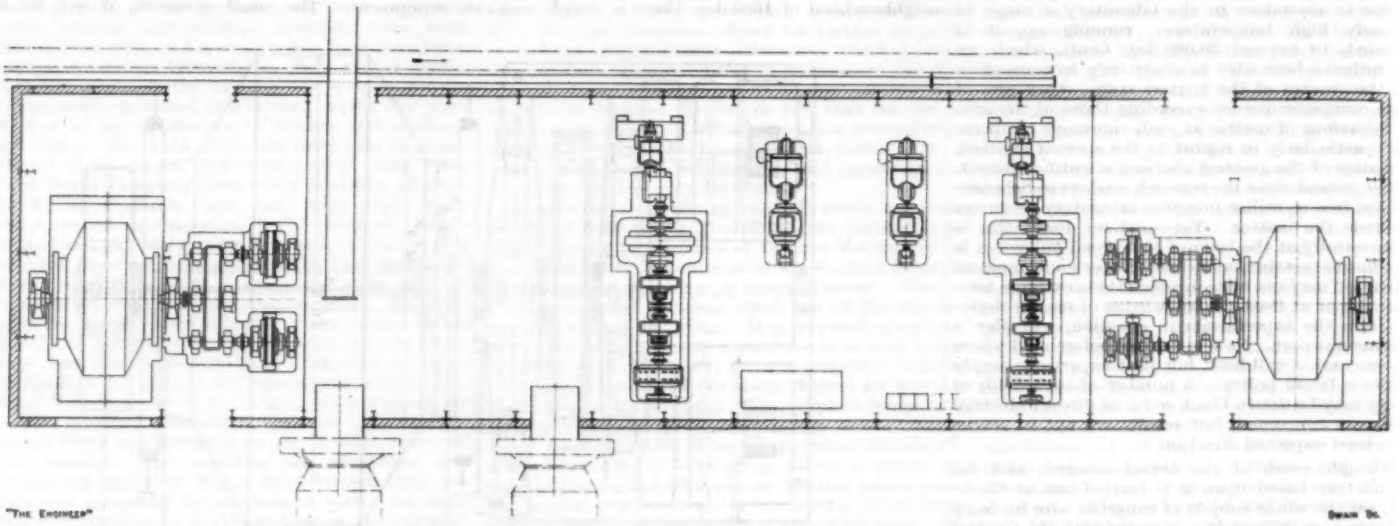


FIG. 61—GENERAL ARRANGEMENT OF WINDING PLANT FOR HARWORTH MAIN COLLIERY

motors. No. 2 pit, which will serve mainly as a standby and for occasional winds, will be equipped with the existing sinking engines. At present it is assumed that during the first stage of development the colliery auxiliary load will average 850 kilowatts during the coal winding shifts, and 500 kilowatts during the night shift, and for this load the 1500-kilowatt turbine will be installed. The existing temporary power plant will act as a standby to this turbo-generator during the first stage. It has been assumed that, in the second stage, the colliery load will have developed to, approximately, 1500 kilowatts, and a second turbo-generator equipment corresponding to the first equipment will be installed as a standby. As the pit develops and the coal increases, No. 2 pit will be equipped with a drum, two winding motors and a turbo-generator equipment, which is to be an exact duplicate of that installed at No. 1 pit. The direct-current switchgear, used in connection with the winders, will be so arranged that either motor generator equipment may be instantly used for either pit, and in the event of a failure of one of the motors or generators, the equipment affected may be run at half load and half speed, and one generator and one motor will only be used.

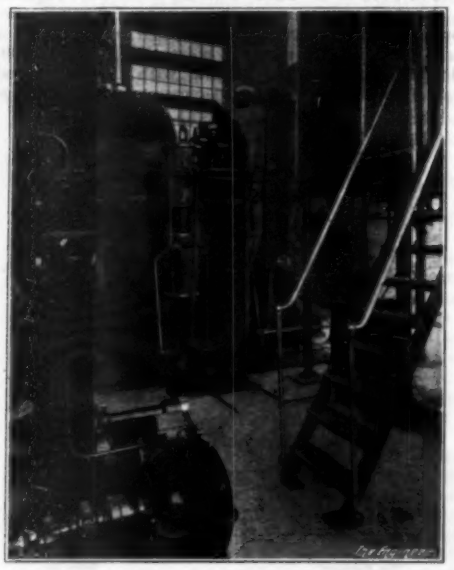


FIG. 62—BRAKE ENGINE AND DEPTH INDICATOR

The plant installed on these lines will, it is considered, result in great financial advantage and at the same time will not confine the colliery company to any definite policy should any unforeseen circumstances occur as the pit develops. During the first stage it has been assumed that the winder of No. 1 pit will be extracting, approximately, its full output of 2000 tons per shift, and that the colliery load for other purposes will be 850 kilowatts during the coal-winding shift and 500 kilowatts during the night shift. Ignoring the steam equipment of No. 2 pit, the total amount of steam used for both winding and auxiliary load during twenty-four hours under these conditions will be, approximately, 510,000 lb. The maximum demand on the boilers will occur during the two coal-winding shifts, and will be, approximately, at the rate of 30,000 lb. of steam per hour. Taking coal at 9500 B.Th.U. per pound, and assuming a boiler efficiency of 75 per cent., the amount of steam evaporated at 180 lb. per square inch gauge with a total temperature of 500 deg., will be 6 lb. per pound of coal. Under these conditions, the coal consumption for twenty-four hours will be 84,500 lb., or 37.7 tons, which represents a considerable saving per annum over any of the competitive schemes put forward to cope with the conditions prevailing at the Harworth Main colliery.

A 1350 horse-power geared alternating current winder has recently been installed by the Metropolitan-Vickers Electrical Company at the Hilton collieries of the Holly Bank Coal Company, Limited, near Wolverhampton. The motor is designed for three-phase, 3300-volt, 50-period current, and it runs at a speed of 288 revolutions per minute. There is nothing new about the design of the motor, but the bearings, slip rings and brush gear have been constructed to withstand the arduous conditions which winding work entails. A view of the brake engine and depth indicator is given in Fig. 62, whilst views of the winding motor, Fraser and Chalmers' winding engine, switchgear, &c., are given in Figs. 64–67 on page 368. The design of winding equipment has been based on the following data :—

Depth of shaft	1800ft.
Output per hour	300 tons
Net weight of coal per wind	13,440 lb.
Number of winds per hour	50
Time of changing tubs	12 sec.
Weight of three-deck cage and chains	11,220 lb.
Number of tubs per wind	9
Weight of nine tubs	5544 lb.
Weight of rope per yard	22¼ lb.
Rope circumference	5.5in.
Centres of headgear pulleys	5ft. 6in.
Horizontal distance between centre of drum and centre of pulleys	120ft.
Vertical height of centre of sheaves from centre of drum	60ft.
Type of drum	Cylindro-conical
Diameter of small drum	11ft.
Diameter of large drum	21ft. 6in.
Turns on small diameter	3
Turns on scroll	5.5
Drum speed	35–45 r.p.m.
Motor rating	1350 horse-power
Synchronous speed of motor	300 r.p.m.
Estimated units per trip	16.4 kilowatt-hour

The controller is of the maker's well-known weir type, with fixed electrodes and adjustable pumping arrangements for the electrolyte, so that the rate of acceleration of the winder is not entirely dependent upon the driver. The controller is fitted with a reverse current-braking device and a slip-reducing device. High-tension stator reversing contactor switches work in conjunction with the weir of the controller. The Metropolitan-Vickers overspeed and slow brake device has been fitted in order to provide additional protection during the full-speed running and retardation periods, and the slow-speed brake protects men against shock and possible injury arising from the sudden stoppage of the winder when running at full speed. The device gives a slow-speed braking

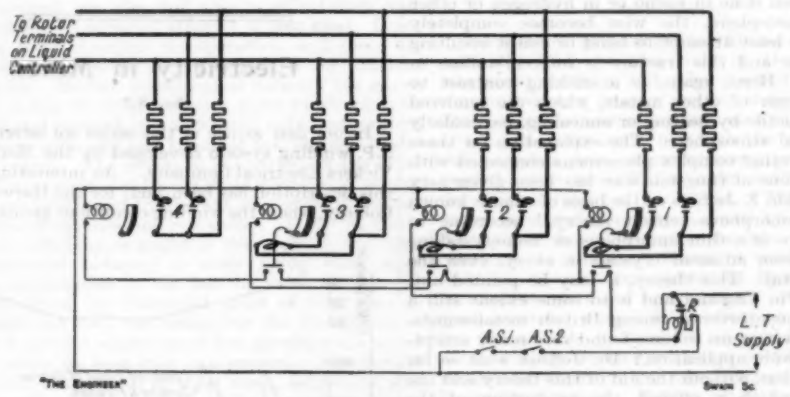


FIG. 63—CONNECTIONS FOR SLIP-REDUCING DEVICE

effect under overspeed conditions, and can be set to give any safe rate of retardation under any conditions, so that the winder is brought to rest without shock or excessive stress. The plant is also provided with one of the Metropolitan-Vickers patented friction-driven limit switches, a low air-pressure trip and a special electrical trip. As shown on page 368, the switchgear controlling the winder is mounted in sheet steel cubicles, and provision is made for a duplicate supply at medium pressure for the auxiliaries used in connection with the winder, such as the oil pump for the winder gearing, the air compressor and the controller pump motor.

With all liquid type controllers a certain amount of resistance remains in circuit when the controller is in the "full on" position, and the motor has reached its maximum speed, and it has been found that a beneficial result on the output from the pit is obtained by the introduction of a slip-reducing device. In the case of one installation it was found from chart and meter readings, taken with and without the slip-reducing gear, that an increase in output of a little over 5 per cent. could be obtained. Another important advantage of eliminating the inherent resistance of the controller during full speed operation is that the solution may be considerably weakened without affecting the output, thereby increasing manœuvring facilities when coming to bank with a resultant saving of time. A slip-reducing device considerably adds to the value of a given equipment, since an increased output is obtained by the saving of the energy which would otherwise be dissipated in the controller during full speed running.

The diagram, Fig. 63, shows the Metropolitan-Vickers' slip-reducing device applied to the winder erected at the Hilton collieries. It consists of a number of double-pole contactors which connect successive banks of resistance in parallel with the controller when the winder is running at full speed. The auxiliary switch A S 1 is coupled to the operating mechanism of the controller and is only closed when

the weir is at the top of its travel. A similar switch, A S 2, is operated from a small paddle by the solution, and is arranged to be closed when the liquid reaches its highest level. When both the switches are closed the relay R is closed, and in turn it closes contactor No. 1, thus inserting the first bank of resistance. All the contactors, with the exception of the final one, are provided with accelerating relays, so that after the current peak due to the closing of No. 1 contactor has subsided, the others close at regular intervals.

Varying Specific Heats and Gas Engine Mixtures.

By TELFORD PETRIE.

THE existence of complications which are caused by the rising values of the specific heats with increasing temperature of all except the monatomic gases, has been fully realised since it was pointed out in 1905 by the committee of the Institution of Civil Engineers, which suggested the air-standard of efficiency. Engineers have felt that the air-standard formula, assuming as it does that the specific heats of the working substance remain constant throughout the temperature range of the cycle, forms an unattainable ideal when the specific efficiency ratio of any particular engine is desired, although it is none the less valuable for comparative purposes.

As a consequence of this, the first task which the Gaseous-Explosions Committee of the British Association—B.A.— assigned to itself was the collation and determination of the variability of the specific heats of such gases as were common in internal-combustion engines. In its first report, in 1908, it published a curve, showing the relation between the increase in internal energy of a hypothetical gas engine mixture and the temperature, which was based on the best information available at the time. The practical value of such a curve, as was first pointed out by the late Professor B. Hopkinson in a paper of the same year before the Institution of Mechanical Engineers, lies in the fact that with its aid a true estimate can be formed of the work done by an ideal engine under any given set of conditions, and so designers are able to obtain efficiency ratios which are comparable with the corresponding Rankine cycle standard of steam engine and steam turbine practice.

If E is the increase of internal energy and $C\,v$ the specific heat of a gas at constant volume, then the two are related by the general formula

$$E = \int C\,v\,dt$$

where dt is the increment of temperature over which the increase takes place. If the specific heat of the gas in question increases as a linear function of the temperature, that is to say, if it conforms to a formula of the type

$$C\,v = a + b\,t$$

then the above expression can be written

$$E = C\,v_m\ (t_2 - t_1)$$

where $C\,v_m$ is the mean specific heat between the two temperatures t_2 and t_1, or is assumed to be

$$C\,v_m = \frac{C\,v_2 + C\,v_1}{2}$$

Theoretically the diatomic gases should all have the same specific heats, and actually such gases as N_2, O_2, CO, H_2, and air, do approximate very closely to theory, and, moreover, do approximate to the above "linear" law of increase, but gases with more than two atoms, such as CO_2 and H_2O—as vapour—appear to be more complex in their behaviour. This can be seen from Fig. 1, in which a number of experimental results have been collected together for comparison. In this chart the temperature scale is in degree Cent. —ordinary—and the specific heats at constant volume are given in molecular heats, or gramme-calories per mol. For engineering computations they may be converted into foot-pounds per cubic foot by multiplying by a conversion factor of 3.90.

The nature of many of the experiments entails the determination of *mean* specific heats ($C\,v_m$) between two temperatures, and such results are shown by broken lines on the chart at the temperatures which correspond to the mean of the temperature range. By exterpolating these mean temperature curves to 0 deg. Cent. and then expanding with the assumption that

$$C\,v_2 = 2\,C\,v_m - C\,v_1$$

actual or instantaneous values for the specific heats between 0 deg. Cent. and 3000 deg. Cent. are obtained.

The mean values for CO_2, H_2O and N_2 are, for the most part, derived from the experiments of Holborn and Henning, Pier and Bjerrum, which were brought to the notice of British engineers by D. R. Pye, and restated by him in the "Dictionary of Applied Physics" (D.A.P.), Vol. I., page 417.

The exterpolation of CO_2 to 0 deg. Cent. agrees very well with Swann's value of 6.93, which was considered by the B.A. to be correct to within 1 per cent.* The hypothetical value for H_2O—as water vapour—at 0 deg. Cent. is not so determinate. The B.A. gives Langen's value of 5.9,† but Sir Alfred Ewing considers that it should be nearly 6.1.‡ If the mean D.A.P. values are exterpolated the result at 0 deg. Cent. would appear to be more like 5.65.

If the latter value is taken for $C\,v_1$ then the upper of the two H_2O curves is obtained for actual values. Using 6.1 gives the lower of the two curves. The difference is of no practical importance, since the mean values between 2000 deg. and 3000 deg. Cent. are not considered to be more accurate than ± 5 per cent., and it would require more than 10 per cent. of H_2O to be present in a gaseous mixture to make a difference of 1 per cent. in the internal energy curve at 3000 deg. Cent..

The figure for N_2 at 0 deg. Cent. is fairly well established at 4.9, in which case the value of 5.17 given in the "Dictionary of Applied Physics" for the mean between 100 deg. and 500 deg. Cent. is possibly a misprint for 5.07. Otherwise the point would not lie on a smooth curve.

The B.A. figures of 1908 for CO_2 and H_2O have been added to the chart for comparison, and also some new results for CO_2 and N_2 which were obtained, amongst others, in the laboratories of the Manchester University by Professor H. B. Dixon and his associates.§

The latter values are actual ones and not, as with previous methods, mean values. They were calculated from extremely accurate measurements of the velocity of sound in the gases which were contained in wound iron or silica tubes and heated to various temperatures up to 905 deg. Cent. The authors state that "no claim is made that these experiments give more exact determinations of the specific heat of gases than those given previously by experiments over low ranges of temperature; the object has been to obtain by comparative measurements the general gradients of the curves rather than to find the exact value at any definite point."

The following expressions are given for the variation of $C\,v$ with the absolute temperature (T):

Gas.	Range, deg. Cent.	Cv.
N_2	0 — 1000 ..	4.775 + 0.00042 T
Air	0 — 700 ..	4.8 + 0.0004 T
CO_2	0 — 600 ..	6.1 + 0.0028 T

It will be noted that the slopes of these curves for CO_2 and N_2 are less than in previous cases, but that in both cases the value at 0 deg. Cent. agrees very well.

If the various curves on this chart are exterpolated down to absolute zero of temperature two curious points are to be noted. With the lower value of 5.65 at 0 deg. Cent. for H_2O, the CO_2, H_2O and N_2 (D.A.P.) curves all meet at absolute zero within 0.1 of a molecular heat unit at 4.8. On the other hand, with the higher value of 6.1 at 0 deg. Cent. for the H_2O curve, the CO_2 curve of Dixon and the H_2O curve of the D.A.P. meet at approximately absolute zero at 6.1.

It would be interesting to know whether these results are merely coincidences or whether they are capable of some physical explanation. Possibly if the Manchester methods could be repeated for H_2O further evidence would be forthcoming. In any case both results can hardly be right, and further light on the subject might be of value in determining the true slope of the $C\,v$ curves.

The significance to the engineer, however, is this: that if formulæ of the type

$$C\,v = a + b\,T \text{ (degree Cent. abs.)}$$

are to be used in thermodynamical relations for gaseous mixtures containing only H_2O, CO_2 and N_2 or their equivalent, then the value for the constant a cannot be less than 4.775, or 18.62 foot-pounds per cubic foot, and it may be more.

Internal energy curves for CO_2, H_2O and N_2 have been calculated from the specific heat curves of Fig. 1, by the step-by-step process, for increments of each 100 deg. Cent. from the relation

$$\Sigma\,E = \Sigma\,C\,v_m\,(t_2 - t_1)$$

where $C\,v_m$ is the actual specific heat at $\frac{t_2 + t_1}{2}$

The results, converted to foot-pounds per cubic foot by multiplying by the factor 3.90, are given in Table I. for each 500 deg. Cent., and are also shown on Fig. 2 against degree Cent. ordinary.

TABLE I.

Temp. deg. C. (ord.)	Internal energy from 0 deg. Cent. (ft.-lb. per cu. ft.). CO_2.		H_2O when C_v at 0 deg. Cent. =		N_2.	
	D.A.P.	Dixon.	5.65.	6.1.	D.A.P.	Dixon.
500	16,200	14,200	12,100	12,400	9,820	9,700
1,000	37,300	31,700	26,600	26,300	20,300	19,600
1,500	61,400	52,000	43,400	42,300	31,500	30,300
2,000	87,500	75,000	63,000	61,400	43,500	41,200
2,500	115,500	100,000	87,000	80,400	56,600	52,500
3,000	144,700	133,000	115,600	108,200	70,700	64,250

In the absence of further experimental evidence the CO_2 values of Dixon are derived from linear exterpolation between 600 deg. Cent. and 3000 deg. Cent. This is pure assumption, but any negative flexure similar to other results would lower and flatten out the internal energy curve derived from this source, so that it may be taken as an upper limit. Similarly the N_2 values of Dixon have been exterpolated from 1000 deg. Cent. to 3000 deg. Cent., but here there is more agreement in the form of the curve with previous results.

If the percentage by volume of the constituents of a gaseous mixture are known or are assumed, then its internal energy curve can be calculated direct

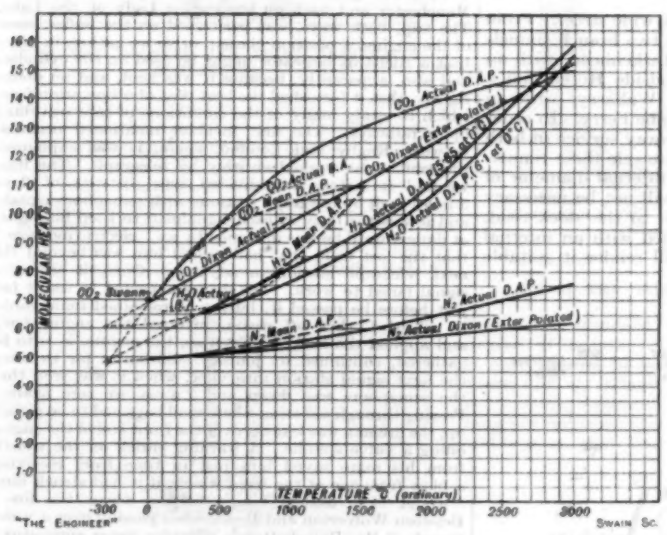


FIG. 1

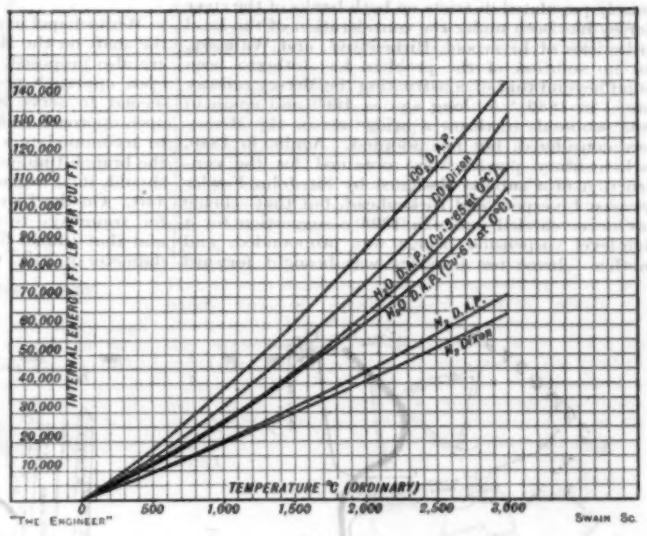


FIG. 2

* B.A., second report, 1909, page 249.

† B.A., first report, 1909, page 328.

‡ "Thermodynamics for Engineers," 1920, page 245 (footnote).

§ "On the Velocity of Sound in Gases at High Temperatures and the Ratio of the Specific Heats," by H. B. Dixon, C. Campbell and A. Parker, "Proc.," Royal Society, A., Vol. 100, 1921.

from these curves. This has been done for the B.A. mixture of 83 per cent. N_2, 12 per cent. H_2O, and 5 per cent. CO_2, and tabulated, together with one or two other internal energy curves in Table II. They require to be plotted on a large scale for suitable comparison.

TABLE II.

Internal energy from 0 deg. Cent. (ft.-lb. per cu. ft.).

Temp. deg. C. (ord.)	B.A. curve of 1908.	B.A. mixture with D.A.P.	B.A. mixture with Dixon.	Tizard and Pye for benzene.	Sir D. Clerk.	W. J. Walker
500	10,400	10,500	10,200	—	11,500	9,460
1,000	22,900	21,800	20,900	—	24,200	20,170
1,500	37,500	34,400	32,800	—	37,800	32,200
2,000	53,800	47,900	45,600	49,980	51,600	45,300
2,500	—	63,300	58,900	65,800	65,500	59,600
3,000	—	79,400	75,000	83,190	79,500	76,400
Col.	1	2	3	4	5	6

NOTES.

Cols. 1, 2, and 3.—B.A. mixture consists of N_2 = 83 per cent., CO_2 = 5 per cent., H_2O = 12 per cent.

Col. 4.—Tizard and Pye give an equation for E between 2000 deg. and 3000 deg. Cent. for benzene mixture when dissociation effects at high temperatures are taken into account—*Automobile Engineer*, Vol. XI., 1921, page 98.

Col. 5.—Sir Dugald Clerk calculated E from his zigzag experiments. The actual values are restated in "Dictionary of Applied Physics," Vol. I., page 306.

Col. 6.—W. J. Walker published an internal energy curve derived from analytical reasoning and actual tests—"Proc." Inst. Mech. Eng., December, 1920, page 1255.

Proposed Tunnel under the River Mersey.

FOR many years the problem of linking up the densely populated districts on both banks of the river Mersey has been under the consideration of the local authorities of Liverpool, Birkenhead, and Wallasey, but no solution of the problem has hitherto been found beyond that of constructing the Mersey railway tunnel in 1886. As long ago as 1860 and again in 1863 proposals to throw a bridge across the Mersey were considered, but not adopted. Again, in 1880, parliamentary powers were obtained for the construction of a subway designed by Sir John Fowler between Liverpool and Birkenhead, but that scheme was never carried out. In 1898 a suggestion for a high-level suspension bridge was propounded, and another scheme for a bridge was brought forward in 1912, but both failed to satisfy the local conditions. The bridge proposed in 1912 was condemned on account of the enormous span—3600ft.—which would have been necessary if piers in the river were to be obviated. In addition to possessing great length, any bridge over the river would have to give a clear headway of 185ft. above high-water spring tides. The estimated cost of the bridge was, exclusive of land, £9,500,000.

With the object of thoroughly considering the project a committee embracing representatives of the different local authorities was formed some time ago, and it appointed Sir Maurice Fitzmaurice, M. Inst. C.E., Mr. Basil Mott, M. Inst. C.E., and Mr. John Brodie, M. Inst. C.E., to advise on the question, and although their report has not yet been published, it is understood that these experts have pronounced emphatically in favour of a tunnel. Their joint report was laid before the committee last week and has now been referred to a further special committee. It recommends the construction of one main tunnel under the river, with an internal diameter of 44ft. The tunnel would start from a shaft to be sunk on a site near the dock offices on the Liverpool side and would pass under the river clear of the Mersey railway tunnel to a shaft to be sunk on the Birkenhead side south of the Wallasey landing stage. As will be noted from the accompanying plan, Fig. 1, two branch tunnels are proposed as exits from the shaft on the Liverpool side, one for the heavy dock traffic with an open approach at New Quay and one for lighter fast traffic and tramway services with an open approach to Whitechapel in a proposed new wide street. From the shaft on the Birkenhead side two branch tunnels are also proposed, one to serve Birkenhead, with an open approach near to the Woodside Hotel, and a second to serve Seacombe and Wallasey, with an open approach near to the Seacombe Ferry. In order to accommodate a complete tramway service in both the branch tunnels on the Cheshire side these tunnels should, it is suggested, have an internal diameter of 44ft. On the Liverpool side it will not be necessary for tramways to use the branch to the dock road, and that tunnel has been designed with an internal diameter of 27ft. 6in., which will render it suitable for two lines of traffic. The branch to Whitechapel, &c., will, however, be 44ft. diameter.

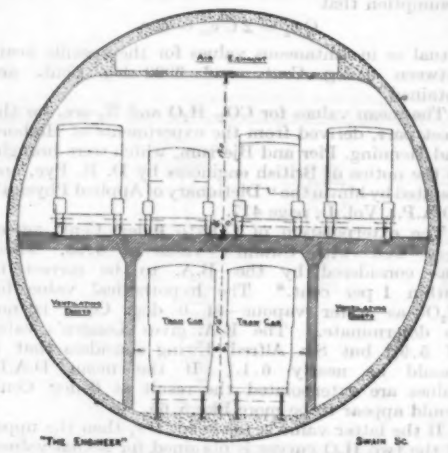


FIG. 2—SECTION OF PROPOSED TUNNEL

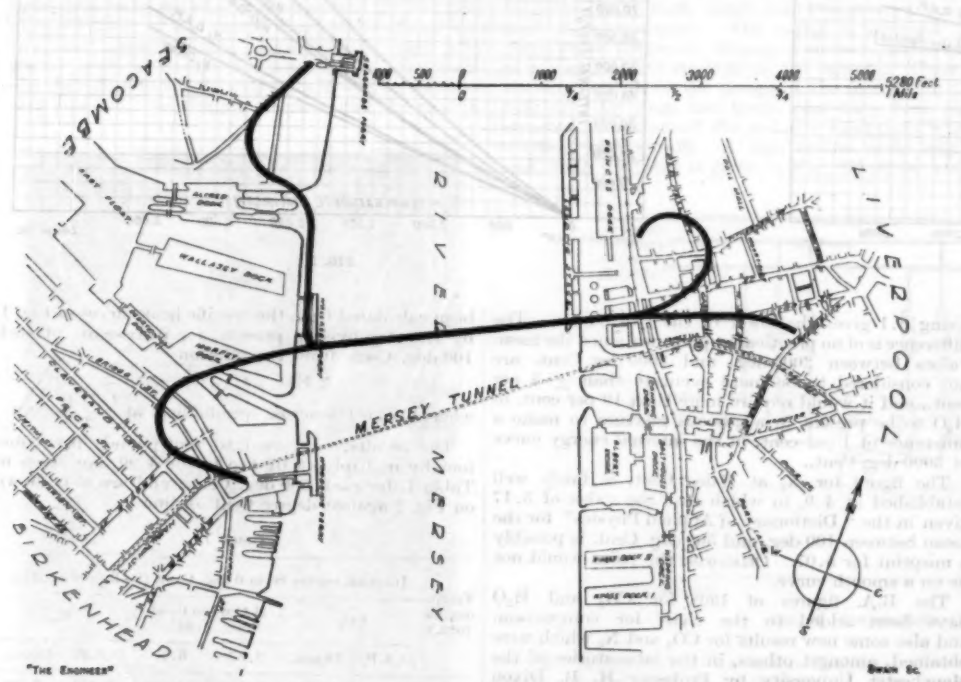


FIG. 1—PLAN OF PROPOSED TUNNEL BETWEEN LIVERPOOL AND BIRKENHEAD

It will be seen from the cross section, Fig. 2, that it is proposed to accommodate roadway and tramway traffic in separate sections, the upper section for ordinary road traffic being 36ft. wide between the kerbstones, or sufficient at least for four lines of traffic. There will also be a footpath along either side. The lower section will accommodate two lines of tramways. The problem of ventilation has not been lost sight of, and it will be seen from the transverse section that two ventilating ducts for fresh air will be provided in the lower half of the tube, while the foul air will be drawn off through an exhaust chamber situated along the upper half of the tunnel. The tunnel itself is to be lined with cast iron segments, which will, in turn, be lined with concrete. Outside the cast iron and between it and the sandstone rock any space which is left will be completely grouted up under pressure with cement introduced in semi-fluid condition through holes in the segments, which can be subsequently sealed up with screwed plugs. The steepest gradient will be 1 in 20 on the Liverpool side for light traffic and tramways and 1 in 30 for heavy traffic.

It is intended, if the tunnel be constructed, that it shall form a continuation of the main thoroughfares on both sides of the river, and as there will be no obstructions due to the stoppage of vehicles, such as is general in streets, high speeds will be possible. The total cost of the undertaking is estimated at £6,400,000, of which amount the tunnel works alone are estimated to cost £5,410,000. As regards the financial side of the scheme, it is suggested that the Government should become responsible for half the cost and that the various local authorities should contribute the remainder. It is estimated that the interest and sinking fund payable by each of the authorities, added to the annual cost of maintenance, would be met by revenue in the shape of tolls.

SIXTY YEARS AGO.

A YEAR or two ago we published a series of articles by Mr. E. C. Poultney entitled "Locomotive Footplate Experiences," in which were described the outstanding facts and incidents of railway travel on the principal lines of this country, as seen from the engine-driver's platform. A journey of a similar nature, performed by a representative of this journal sixty years ago, was described in a leading article in our issue of October 2nd, 1863. It may be that incidents during railway travel are now much less frequent than they were six decades ago, or that we nowadays accept them as too commonplace to mention. Certain it is that Mr. Poultney recorded nothing in his whole series of articles half as exciting or startling as the incidents which befel our representative in 1863 during the course of his journey from London to Manchester and back on the engine Lady of the Lake. The trip, both ways, was performed on the buffer beam of the engine, a position chosen, or so we gather, in order that a Richards indicator might be used on the cylinders and also, apparently, because it was held, and no doubt rightly, that it furnished the best post of observation from which to study many of the conditions of safe travelling upon railways. The first incident mentioned occurred between Rugby and London, where, it was explained, the traffic was worked entirely by telegraph. The line, we find it stated, was divided into districts of 2 or 3 miles each by telegraph stations with semaphore signals, and it was the duty of each signalman to keep his signal at danger until he was informed by an "electric message" that the last train that had passed him was beyond the next telegraph station in advance. Once, it seems, a signal failed to work. The driver expected to see it fall just before he passed it, but, as it remained immovable, he whistled, shut off steam, reversed the engine (*sic*), and applied the brakes. Even so, the engine, it is to be gathered, continued its journey sufficiently far to bring the next signal station into view, when it was seen that the semaphore was down and "away we tore again." Passing through a station where mail bags had to be picked up, the fireman was leaning over the front end of the engine oiling a valve spindle. A warning shriek on the whistle from his mate saved him just in time from receiving a blow from one of the bags, which, if it had struck him, "would have dashed him, a corpse, across the line." Between Wolverton and Rode, when passing over a water trough, "Mr. Ramsbottom's effective scoop apparatus" was not raised quickly enough, with the result that "the front carriage was deluged with water, which poured like a cataract over upon the train." An involuntary stop had to be made at a roadside station, for it was discovered that sand had been blown up from the line on to one of the guide bars, with the result that the oil thereon was one moment smoking and the next in a blaze. Fresh oil only increased the flames, and the engine had, consequently, to proceed to the next water crane, where twenty or more buckets of water were dashed over the heated parts. When cooled sufficiently the guide blocks were raised and the surfaces wiped out with a thread of spun yarn. Truly, an exciting journey, especially for one perched upon the buffer beam. Whether it all did occur on the one journey, or whether the events mentioned were intended to indicate common incidents of railway travel in 1863, there is now no evidence to show.

CANALS CONVERTED INTO RAILWAYS.

WITH the abandonment of the old Erie Canal following the construction of the larger barge canal from Lake Erie to the Hudson River, some cities have found means to utilise the abandoned canal bed. At Rochester four lines of rails are being laid in the old canal for a length of about 13 miles, that part in the centre of the city being covered by a concrete deck to form a broad street. Three rows of columns support this deck. Two of the tracks are destined for local goods service, connecting with all the steam railways and having spurs or branches into all the manufacturing plants along the route. The other two tracks will be used for the several electric interurban railways, thus removing their cars from the tramway lines. An aqueduct crosses the river, and on its old floor rails will be laid, while columns on the side walls and in the centre will carry an 80ft. street. At Syracuse it is proposed to divert a main-line railway to the old canal, thus providing for better development of the city and improved railway facilities. In somewhat the same way the end of the old abandoned Miami Canal at Cincinnati, Ohio, is being utilised for an electric underground railway. Two rectangular "tubes" of reinforced concrete are being built and will extend to the heart of the city. Further out it will be an open-air line, with rails laid in the old canal.

The Shipping, Engineering and Machinery Exhibition.

No. VI.*

A very fascinating exhibit was that of the Pitter Gauge and Precision Tool Company, Limited, of Upper Market-street, Woolwich, S.E. 18, which comprised a collection of apparatus for measuring with a degree of accuracy hardly attainable heretofore. The gauges of this company have, in fact, made it possible to take measurements in the ordinary

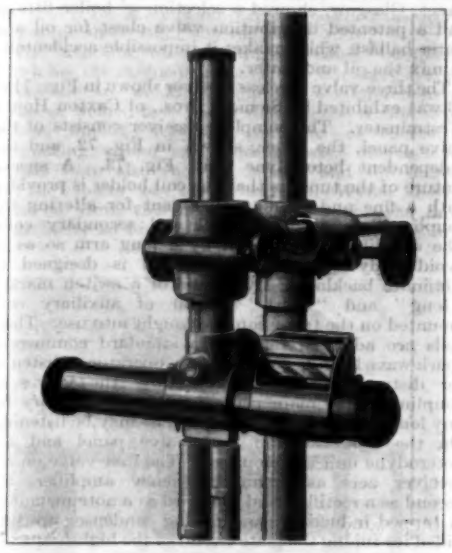


FIG. 66—THE BROOKES AND SEARS "GENERATOR COMPARATOR"

course of workshop practice in steps of 0.00001in. The basis of the whole system is the "generator comparator"—shown in Figs. 66 and 67—which was developed at the National Physical Laboratory by Messrs. A. J. C. Brookes and S. E. Sears, together with the Department of Scientific and Industrial Research. Mr. Brookes, by the way, is now working with the Pitter company. The machine, as its name suggests, is used for comparing the lengths of gauges and has

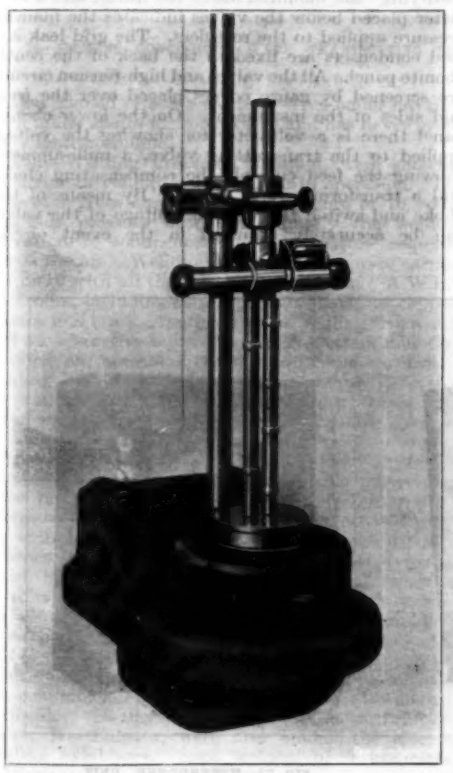


FIG. 67—THE BROOKES AND SEARS "GENERATOR COMPARATOR"

an accuracy which is said to approach one-millionth of an inch. It is really a very sensitive level which is mounted on the top of the bars to be compared. A reading is taken of the position of the level bubble and the positions of the bars are reversed by rotating the little turntable on which they stand, and another bubble reading is taken. Half the difference in the two positions of the bubble is, of course, a measure of the difference in the lengths of the bars. In the case of the machine exhibited, the level tube is curved to a radius of 700ft., while the supports on which it rests on the gauges were 0.7in. apart. It will thus be seen that a very high degree of magnification is provided for, which may be gauged by the fact that the heat of the hand applied to one of the test specimens for only a few seconds will expand the bar enough to give a very perceptible reading. With the assistance of this comparator it has been possible to sub-

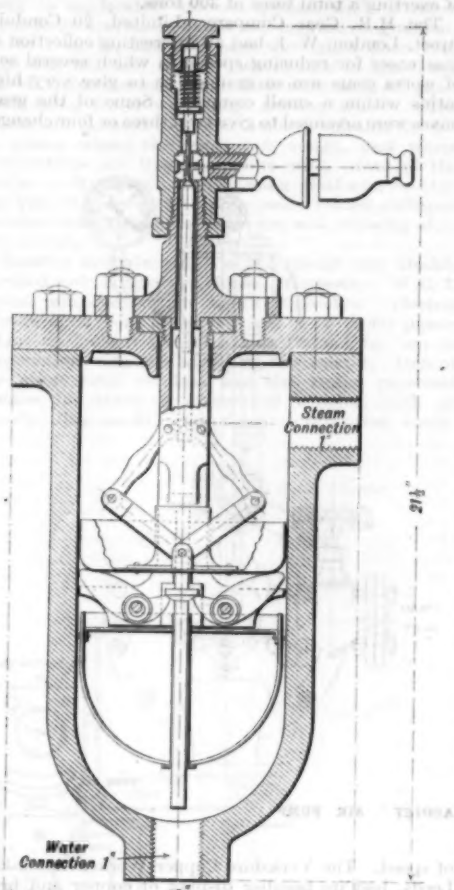


FIG. 68—THE HILO BOILER WATER ALARM

divide the standard yard with an extremely high degree of accuracy, an accuracy which, in fact, is only limited by commercial considerations. The process is as follows:—Having obtained an exact copy of the standard yard, three bars just over 1ft. long are prepared and are progressively lapped down endways so that they compare one with the other exactly, and also, when wrung together end to end, compare with the standard yard. In this way three gauges precisely 1ft. long are obtained and by a similar process gauges of other lengths less than a yard are produced. A set of bars includes one each of 32in., 23in., 15in., 8in., 7in., 6in., 5in., 4in., 3in. and 2in., and two 1in. bars. They are all lapped true across the ends, and are provided with an easy-fitting screw connection so that they may be joined together and any length, in inches, from 2in. up to 39in., obtained with two bars only.

For dimensions less than 1in. slip gauges are used. They are produced by an ingenious system of lapping that ensures them having absolutely parallel faces. With the aid of these slips, in combination with the end bars, every size from 0.3in. up to 36in. can be obtained to the nearest 0.00001in., and the remarkable feature about the system is that the whole of the necessary equipment costs no more than a horizontal measuring machine, the accuracy of which is dependent on the fit between the screw and its nut. The great value of the system is that the bars can all be made true to length within the limit of accuracy of the method, and within this limit all will be accurate subdivisions of the parent standard, the initial tolerance on which is distributed proportionately, according to length, amongst all the pieces generated from it. It is worthy of remark that the precision now attained in the manufacture and measurement of these gauges is such that the greatest uncertainty in the whole operation is that involved in determining the parent end standard in the first instance in terms of the fundamental line standard.

Besides the apparatus to which we have already referred there was on the stand of Ronald Trist and Co., Limited, of 12, Clipstone-street, London, W. 1, an example of the new Hilo water alarm for boilers—shown in Fig. 68. This apparatus is entirely external to the boiler, with which it is connected by steam and water pipes so that it stands at the normal working level of the water. As will be seen from the drawing, it comprises a chamber in which there are two open floats, one above the other. These floats are connected together by two trigger-shaped levers, and with the spindle of a valve at the top by a toggle joint. This valve is used to admit steam to a whistle to sound the alarm. In operation both buckets are full of water, the lower bucket being submerged in the water contained in the float chamber. The upper bucket then depresses the set of pawls on which it rests. If the water falls below safety point, the lower bucket is no longer submerged and causes by its weight the opening of the valve which operates the whistle. If the water in the float chamber rises unduly the upper bucket becomes submerged, its effective weight becomes less, and the lower float takes charge, operates the valve and sounds the alarm.

Aerostyle, Limited, of 35, St. Bride-street, London, E.C. 4, were demonstrating the capabilities of a very handy form of portable paint sprayer, which we illustrate in Fig. 69. One of the greatest merits of this apparatus is the promptness with which it starts and stops spraying in response to the control trigger, while pulsations from the air compressor are damped out by passing the air through the local receiver B. The pressure air is connected up at A, and a Y piece supplies the two reducing valves C

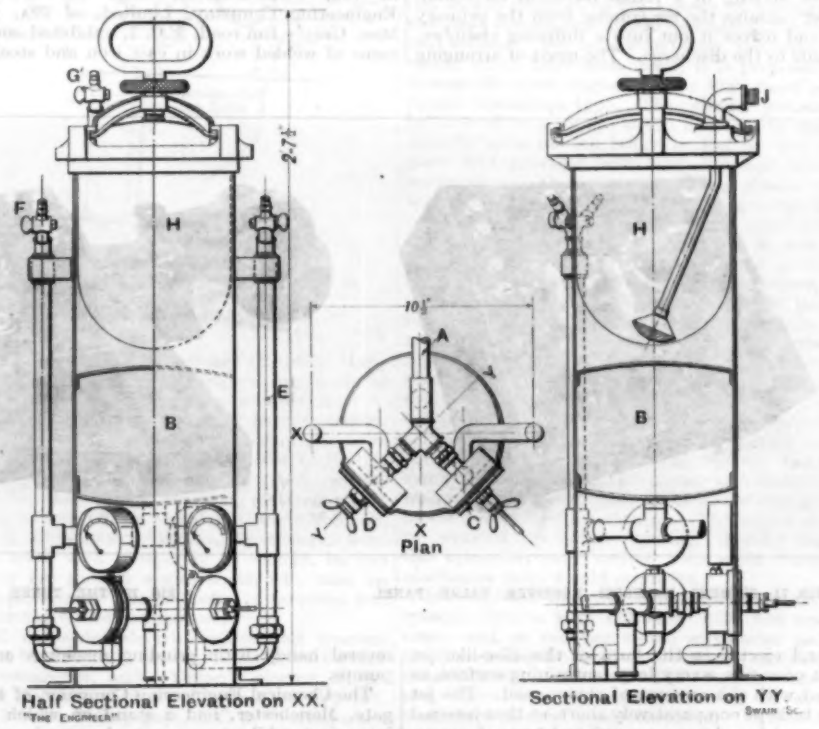


FIG. 69—THE AEROSTYLE PORTABLE PAINT SPRAYER

and D. The air passing C goes up the pipe E, which has a connection with the bottom of the receiver B. The air from the other reducing valve D goes directly to the cock F—the T piece at the bottom of the standpipe on this side is merely a steady, and not a connection with the receiver. A rubber connection is

* No. V. appeared September 28th.

arranged between the cocks F and G, so that air pressure is supplied to the top of the paint vessel H. The paint outlet J is provided with a strainer, as shown, which comes away with the lid when the latter is removed. The lid also serves to hold the paint container in the main casing. It is thus a very simple matter to remove this vessel for cleaning preparatory to recharging. The flexible connections to the spraying pistol are, of course, taken from the paint outlet and the cock on the top of the standpipe E. The whole apparatus is a good solid job, but yet is easily within the capacity of a man to carry about.

John Musgrave and Sons, Limited, of Bolton, concentrated chiefly on a display of Radojet air pumps, a section through which we give in Fig. 70, for extracting the non-condensable vapours from condensing plant. The Radojet extractor is of the two-stage type, and the primary section is of more or less normal design. This part, which can be seen in the upper part of the diagram, is a simple ejector with multiple jets. The discharge from this ejector is taken into a chamber which somewhat resembles the casing of a centrifugal pump. In the place of the impeller, however, there is a pair of fixed discs, arranged quite close together in an axial direction. Steam is supplied to the space between these discs, and emerges as a thin sheet moving in a radial direction all round. This sheet entrains the air coming from the primary ejector, and drives it out into a diffusing chamber, which leads to the discharge. The merit of arranging the second ejector in the form of this disc-like jet is that it possesses a very large entraining surface, as compared with the amount of steam used. The jet can also be kept comparatively short, so that internal losses caused by eddying are reduced to a minimum, and the stability of the ejector is greatly improved. The makers say, as a matter of fact, that the Radojet air pump will maintain its specified vacuum, without adjustment, regardless of the air leakage into the system, barring, of course, gross carelessness, such as a large cock being left open to atmosphere.

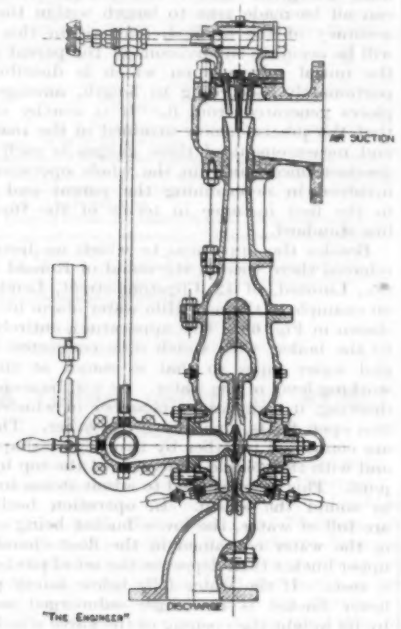
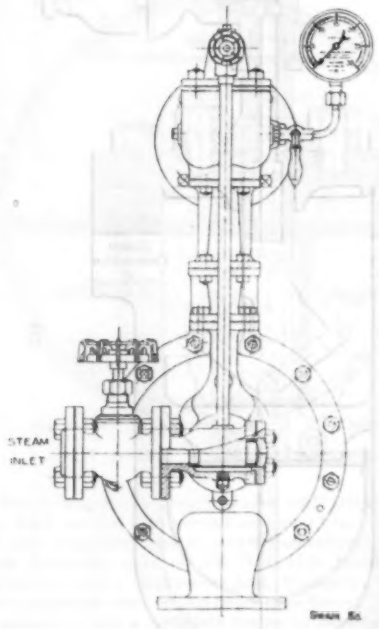


FIG. 70—MUSGRAVE "RADOJET" AIR PUMP

Hollings and Guest, Limited, of Thimble Mill-lane, Birmingham, had a stand on which there were exhibited several hydraulic presses that have already been described in THE ENGINEER, together with a new marine propeller starter. The starter is really a ring of short hydraulic jacks for forcing propellers off their tail shafts. The jacks are arranged in four arc-shaped casings, so that they can be fixed between the propeller boss and the stern post, and are capable of exerting a total force of 300 tons.

The H.R. Gear Company, Limited, 20 Conduit-street, London, W. 1, had an interesting collection of gear cases for reducing speeds in which several sets of worm gears are so grouped as to give very high ratios within a small compass. Some of the gear-boxes were arranged to give two, three or four changes of speed. The Yorkshire Copper Works, Limited, of Leeds, had its familiar display of copper and brass tubes, while the Cape Asbestos Company, 23, King-street, E.C. 2, exhibited asbestos lagging and allied materials, and Nobel Industries, Limited, Buckingham-gate, S.W. 1, displayed a large variety of its products, including the plastic wood, with which we have already dealt.



There were a great number of stands devoted to acetylene welding plants, and besides those to which we have already referred, there were the Thorn and Hoddle Acetylene Company, Limited, of 151, Victoria-street, Westminster, and Allen-Liversidge, Limited, of 106, Victoria-street. The Auto-Welding and Engineering Company, Limited, of 29A, Portpool-lane, Gray's Inn-road, E.C. 1, exhibited some specimens of welded work in cast iron and steel, besides several handy little grinding machines and rotary pumps.

The Chemical Engineering Company, of 49, Deansgate, Manchester, had a stand on which the most important exhibits were several examples of the Kek centrifugal grinding mill that was so largely used for preparing explosives during the war, together with a water-softening plant, a densimeter for boiler water and an ejector apparatus for keeping the water entering economisers at a temperature sufficiently high to prevent corrosion.

Lacy-Hulbert and Co., Limited, Boreas Works, Beddington, Croydon, exhibited a number of the type of air compressor in connection with which their name is familiar, and a new design for small outputs, which is noteworthy on account of the high speed at which it runs and its consequent small overall dimensions.

Ransomes and Rapier, Limited, 32, Victoria-street, Westminster, exhibited a new trailer crane, B. J. Hall and Co., Limited, Chalfont House, Great Peter-street, S.W. 1, a selection of drawing-office equipment, including the blue-print machine which we recently described, and John Kirkaldy, Limited, 101, Leadenhall-street, E.C. 3, a CO_2 refrigerating plant, a marine type evaporator and some feed-water heaters. Messrs. A. Cockburn and Co., of Gateside-street, Glasgow, showed a selection of boiler fittings and a patented distribution valve chest for oil and water ballast, which makes it impossible accidentally to mix the oil and water.

The three-valve wireless receiver shown in Figs. 71 to 73 was exhibited by Siemens Bros., of Caxton House, Westminster. The complete receiver consists of the valve panel, the tuner, shown in Fig. 72, and the independent heterodyne unit, Fig. 73. A special feature of the tuner is that the coil holder is provided with a fine and coarse adjustment for altering the coupling between the aerial and secondary coils. The coupling is controlled by a long arm so as to avoid body capacity effects, and is designed to eliminate backlash. By means of a switch marked "long" and "short" a pair of auxiliary coils mounted on the tuner can be brought into use. These coils are adjusted for use on standard commercial spark wave lengths and enable an operator to listen-in for distress calls without altering the valves or coupling of his main tuner from that necessary for any long wave reception to which he may be listening. On the bulkhead the three-valve panel and the heterodyne unit are mounted. The first valve on the receiver acts as a high-frequency amplifier, the second as a rectifier, and the third as a note magnifier. A tapped inductance and tuning condenser are provided for tuning the plate circuit of the high-frequency valve. The heterodyne unit has a wave range up to 2000 m. and is coupled to the tuning coils by means of a coil mounted in the coil holder on the tuner, and continuous wave signals of any commercial wave length can thus be received.

The continuous-wave wireless telegraph transmitter shown in Fig. 74 was also exhibited by Siemens Bros. The overall dimensions of the apparatus are 2ft. 2in. by 1ft. 7in. by 3ft. high. The aerial inductances and reaction coil are mounted at the top and tappings for varying the wave length are brought out to insulators on the face of the inductance case. The three valves—one transmitting and two rectifying—are mounted inside the frame, and a voltmeter placed below the valves indicates the filament pressure applied to the rectifiers. The grid leak and feed condensers are fixed to the back of the centre ebonite panel. All the valves and high-tension circuits are screened by gauze covers placed over the front and sides of the instrument. On the lower ebonite panel there is a voltmeter for showing the voltage applied to the transmitting valve, a milli-ammeter showing the feed current, the compensating choke, and a transformer ratio switch. By means of this choke and switch the working voltage of the valves can be accurately adjusted in the event of the generator pressure falling below its normal value of 220 volts. The filament transformer, smoothing condenser and air core choke are placed on the base-board of the instrument, the insulation being uniformly good throughout.

One of the most interesting machines shown by the Swedish General Electric Company, of 5, Chancery-lane, was a three-phase variable-speed commutator motor. The speed of these machines can be varied over a very wide range, namely, three to one, the changes in speed being made by a simple brush-shifting device, which can be operated either mechanically or electrically. The motor has shunt

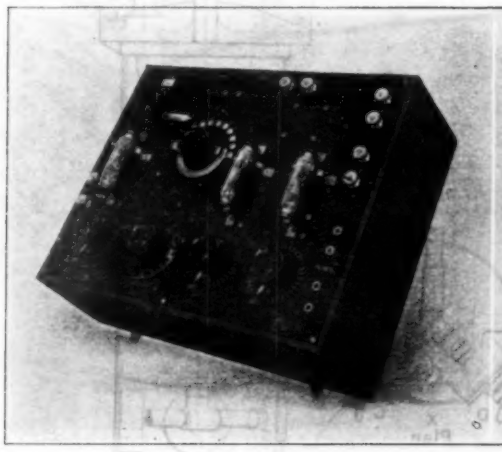


FIG. 71—SIEMENS WIRELESS RECEIVER VALVE PANEL

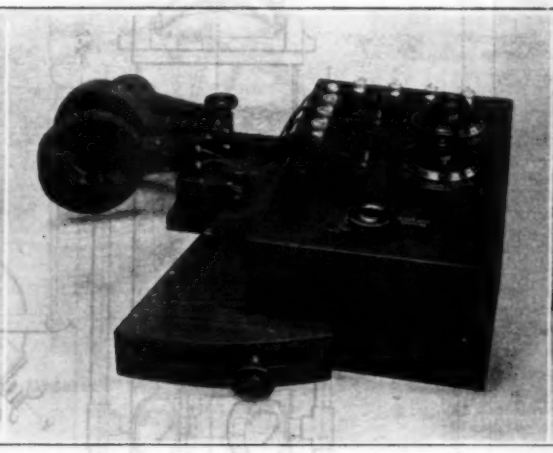


FIG. 72—THE TUNER

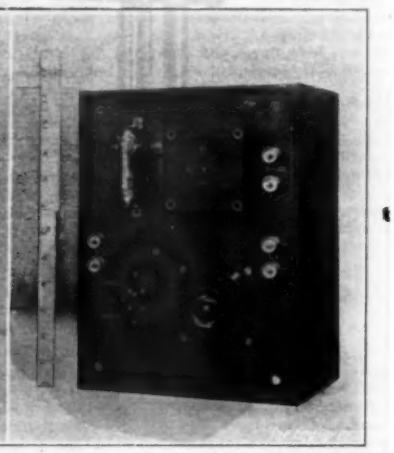


FIG. 73—HETERODYNE UNIT

characteristics, so that the speed is independent of the load and the efficiency and power factor remain at a high value at all speeds within the range of the machine. Examples of the firm's well-known Century single-phase motors repulsion were also on view. These motors are made in sizes ranging from ½ to 40 horse-power and for all commercial frequencies and voltages, and are capable of exerting a high-starting torque. Other exhibits consisted of shunt-wound interpole direct-current motors and three-phase induction motors, including a 250 horse-power machine designed for a speed of 480 revolutions per minute and a pressure of 3000 volts. This type of machine is fitted with explosion-proof slip rings and is specially designed for use in fiery mines. There was also a 150 kilovolt-ampère oil-cooled transformer and some interesting control gear.

The exhibits of the Anglo-Swedish Company, which has the exclusive rights of the Kjellberg system of electric arc welding, comprised a comprehensive series of welded test pieces showing the results after tensile, impact, torsional, modulus of elasticity, alternating stress, and bending tests. Microphotographs were also shown. Models and full details of the joints of the Hawthorn-Wyber boiler were on view, this being believed to be the only large boiler so far constructed with the main joints

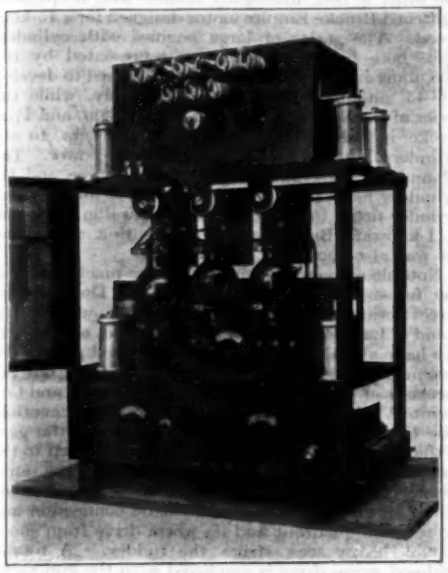


FIG. 74—SIEMENS CONTINUOUS-WAVE TRANSMITTING SET

welded instead of being riveted. This boiler has now been under steam for some years and has never given the slightest trouble.

Alloy Welding Processes, Limited, were showing an engine-driven arc welding plant in operation. The generator gives an open circuit pressure of 70 volts, but this pressure drops immediately the welding operation is commenced to the pressure required across the arc. Welding demonstrations were carried out daily with all the well-known types of "A.W.P." electrodes, including those specially made for copper, bronze, and brass. Another electric welding firm which had an attractive stand was G. P. Petters and Co., Limited, the makers of the Wilson Plastic-arc electric welding apparatus. A single-arc motor generator set was exhibited and welding demonstrations were given at frequent intervals. The Premier Electric Welding Company was exhibiting an up-to-date range of electric welding equipment and accessories. The most notable exhibit was a multiple-arc welding plant designed for supplying two or more welding operators. The high starting voltage necessary for arc welding is obtained by means of a small dynamo in series with the main generator, and this dynamo, which has a small current output at a pressure of 35 volts, is automatically cut out of circuit as soon as the arc has been formed. The power required to drive this equipment is said to be approximately one-half of that needed by an ordinary multiple-operator plant. Alternating-current arc welding plant and the company's Premier electrodes were also shown.

Buckley, Saunders and Co., Limited, of 8, Prince's-street, Westminster, were also among the electric welding exhibitors. Spot welders of 3 kilowatts, 6 kilowatts, and 10 kilowatts were on view, the machines being designed for continuous operation on mild steel, iron, brass, nickel aluminium, stainless steel, and other alloys, and being fitted with a trip switch for cutting off the current when working on springy metal, a current regulator, a swivelling pedal, and adjustable arms. There were also butt welders of 3, 6, and 30 kilowatts capacity.

The British Arc Welding Company was showing photographs illustrating typical welding plants, &c., a shaft built up by welding, and an experimental tank made to instructions from Lloyd's Register of Shipping and embracing numerous combinations of welded and riveted seams tested by Lloyd's representatives.

There was a very good display of electric trucks and cranes. Ransomes, Sims and Jefferies, Limited, of Orwell Works, Ipswich, were showing one of their well-known 15-cwt. electric runabout cranes, as described some time ago in our columns. The crane will travel, hoist and derrick under its own power, and will turn about its own centre like a turntable. The wheel system is designed to enable the crane to adapt itself to moderately uneven ground without detriment to its operation, and it will operate on gradients up to 1 in 10, and will pass through a door 10ft. high and 5ft. 4in. wide. Two models of the firm's Orwell industrial electric trucks were also on view, both being fitted with large trailing wheels. The trucks are claimed to be particularly suitable for use in places where the ground is rough, and where obstructions are frequently met with. One of the trucks is fitted with an elevating platform, so that the vehicle can be run under ready-loaded stillages. Besides these trucks the firm was also showing electric motors.

Another firm showing electric trucks was Hesko, Limited, of Kingsway House, Kingsway, W.C. 2. There was one of the firm's "London" electric trucks of 2 tons capacity and a 3 horse-power "London" electric tractor and trailers for use in conjunction with the trucks or the tractor. One of the most novel exhibits was the Hesko patented stacker for stacking cylindrical articles, such as barrels. The machine was shown in operation, stack-

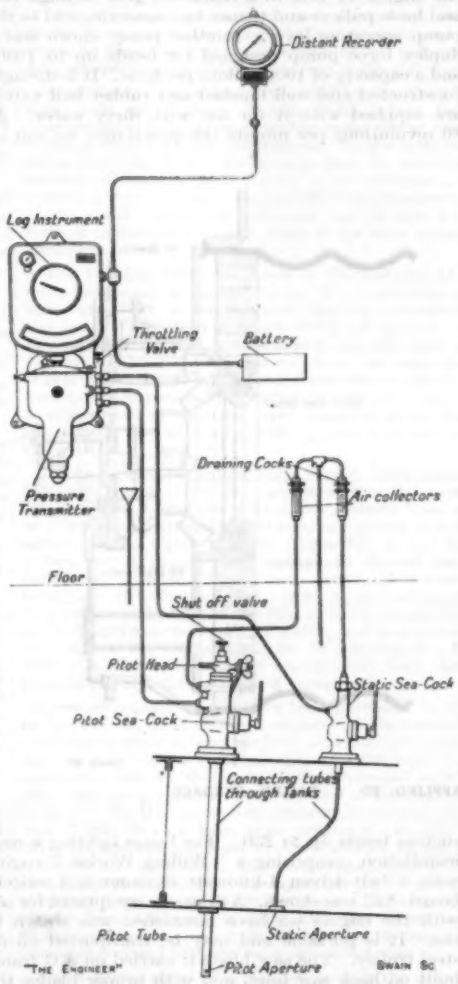


FIG. 75—A "SAL" LOG INSTALLATION

ing barrels at the rate of three per minute. Many other labour-saving devices were shown, such as overhead runways, jib cranes, hand winders, &c.

The latest models of the Greenbat electric trucks, made by Greenwood and Batley, Limited, were shown by W. Goodyear and Sons, Limited, of Dudley Works, Worcs. Besides the ordinary trucks with a fixed platform, there was an elevating platform truck, designed for arduous duty. British Electric Vehicles, Limited, of Churchtown Works, Southport, were showing a truck with a capacity of 5000 lb. for use at docks or for general works transport; also an electric locomotive for use at docks, in factories and mines or for the use of contractors.

Railodok industrial electric trucks and tractors were shown by Walker Vehicles, Limited, of Caxton House, Westminster, and "Union" electric trucks by Joseph Booth and Sons, Limited, of 126–128, Hamilton House, Bishopsgate, E.C. 2. Perhaps the most notable exhibit on the latter firm's stand was a 10-ton electric locomotive or tractor, designed for running at three speeds in either direction, and being sprung on each axle.

Henry Hughes and Son, Limited, of 59, Fenchurch-street, was represented by a display of the firm's well-known navigating instruments, including the "Hunson" bridge sounding machine, ships' clocks and chronometers. A novelty was the new Admiralty pattern "dead-beat" compass, which has been designed to meet the more severe compass conditions which are met with in ships of larger tonnage with increased height of bridge. The outstanding features of this compass are its increased directive force and sensitiveness, while its behaviour is stated to be non-resonant and extremely steady. It has a small-diameter card and may be fitted in either standard or steering binnacles. Another noteworthy instrument on this stand was the Sal Log. This pressure log is at present made in Sweden, and Henry Hughes and Son are agents for it in this country. So far it has been successfully applied, we are told, to over 200 ships and is largely used by the Japanese Navy. The accompanying drawing, Fig. 75, shows the general outlay of the installation. It will be noted that in the bottom of the ship there are mounted two sea cocks, one for the Pitot tube and aperture and one for the static aperture. The water pressure at these two apertures is transmitted by means of pipes through an air collecting and draining device to the pressure transmitter, which is made integral with the log instrument. Inside the transmitter is placed a moving diaphragm, the position of which is controlled by the balance of pressure between the static and Pitot apertures. When the ship moves the increased pressure in the Pitot tube raises the diaphragm and by means of a rod and angle lever moves the indicating and recording mechanism of the log instrument. This part of the apparatus must always be kept below water line level, so that the leads are at all times fully charged with water. At the side of the instrument is placed a throttling valve, so that by its operation the instrument may be protected against excessive pressures and shocks incident to rough weather. In order to make possible the transmission of the readings to other parts of the ship an electrical system is employed, which registers the reading on repeating distant recorders by closing the battery circuit every fortieth of a nautical mile. The design of the Pitot sea cock has been carried out in such a manner that the tube may be withdrawn for examination or replacement and so that when setting the tube the aperture is always placed in a definite position. The various parts of the installation show care in their detail, and the instrument is certainly an advance on the ordinary towed log. An important feature is that the record is not interfered with when the ship is stopped and advanced short distances.

The Parsons Marine Steam Turbine Company, Limited, Turbinia Works, Wallsend-on-Tyne, showed models of various arrangements of geared turbine machinery and examples of gearing and pinions and specimens of the Parsons type "end-lightened" reaction blading. At the meeting inaugurating the exhibition nearly a year ago Sir Charles Parsons expressed his belief in the future of the small cylinder multi-unit Diesel engine for ship propulsion. Two of the most interesting models on the stand showed examples of geared oil engines of this type applied to a single-screw vessel. In both cases the designs had been worked out for a total of 1200 shaft horse-power with two and four-engine units respectively. Each engine has six cylinders and would be designed to run at 450 revolutions per minute in the case of the four-unit scheme and at 300 revolutions for the twin-unit scheme. We understand that, following experiments which have been made, it is proposed to use four-stroke cycle engines of the high-speed enclosed forced lubrication type. The cylinder jackets are to be allowed to generate steam and will be connected directly to a marine boiler heated by the exhaust gases and provided with an additional burner for warming up. On each engine is an elastic coupling with a friction clutch and reduction gearing, the propeller speed being a low one of 75 revolutions per minute. The main advantage claimed for this system is that the engine cylinders are small in diameter and the engine parts are therefore of a size convenient for handling. With the clutch arrangement, moreover, in the event of any effect developing in one of the main engines, that unit may be cut out and the defect remedied without stopping the vessel. An advantage conferred by the hot cylinder jacket is that a lower compression pressure may be utilised in the main cylinders with an increased margin of safety. The temperature of the jackets, which will be in direct communication with the boiler system and at the same temperature as the steam at boiler pressure, makes possible, if desirable, the use of steam instead of compressed air for starting. The engine may also be warmed up before starting, thereby rendering this operation more certain than when starting the machinery from a cold condition.

It is claimed that the multi-unit geared oil engine system gives a high efficiency with low operating costs, and as familiar steam auxiliaries and deck machinery may be used, an element of simplicity and reliability is introduced. The designers also state that there is a considerable saving in weight of machinery and in space occupied. Extensive tests have been made with an experimental engine, and we await with interest the application of this new system to an ocean-going vessel.

At the stand of H. Dodgson White, Limited, 18, Glenville-grove, London, S.E. 8, was shown and demonstrated a new "Service" black paint possessing, it is claimed, remarkable anti-corrosive and anti-fouling properties. Painted test samples were exhi-

bited indicating the resisting powers of the paint against acid and alkali solutions, and the paint is stated by the makers to resist heat up to 600 deg. Fah. An interesting quality of "Service" black is its large covering capacity and the bright varnish finish it gives on drying. Its covering capacity is estimated at 1000 square feet per gallon, or nearly 10,000 square feet per hundredweight. One undoubted advantage of "Service" black is that it, apparently, may be painted directly on to a wetted surface or, if necessary, put on under water, which means that, provided the men can work, a painting job will not be delayed by inclement weather. Owing to its thin and even consistency it has good penetrating properties and may be used with good effect on rusted structures after the flake rust has been removed. We understand that it has been used with success on the Teddington Suspension Bridge, where it was sprayed into places which were not accessible by ordinary brush methods of application.

Slack and Parr, Limited, of Kegworth, near Derby, and Farringdon House, Charing Cross-road, London, W.C. 2, showed a small marine motor of novel design. It is termed the "Harmonic Six," and is a three-cylinder monobloc engine working on the two-stroke cycle and developing at normal rating about 6 horse-power. In the construction of the engine a bold departure from usual practice has been made. It may be said to consist of two main castings, an upper block of three power cylinders and a lower block of three pump cylinders, with vertical passages in both castings for the reception of the mixture prior to its transference to the power cylinders through pressure-operated valves on the heads of the cylinders. Supported in bearings between the upper and lower cylinder casings is the three-throw crank shaft, each throw of which is connected to the double piston by means of a slide block which replaces the usual connecting-rod. An important principle in the design is that the lower portion of the double pistons are alone employed to maintain the axial alignment of the pistons in the cylinders, only the three piston rings making contact with the walls of the power cylinders. This arrangement is said to reduce the friction very considerably. The lubrication of the power cylinders is effected by oil mist passing through ports in the piston skirt, while the overrun of the slide blocks from the crossheads ensures a particularly effective means of lubricating these bearings by entraining a wedge-shaped film of oil between the surfaces each time the block begins its return motion. The crank shaft is furnished with oil passages and other parts of the engine are oiled by a drip feed arrangement worked by the pressure of the mixture in the pump receiver. In the bases of the engine is a simple one-piece rotary valve which controls the intake and delivery ports of the charging pumps. A model running on gas was exhibited and ran very quietly.

One of the most complete exhibits of oil-burning systems was that to be seen on the stand of the Wallsend Slipway and Engineering Company, Limited, Wallsend-on-Tyne. The apparatus shown included one of the firm's new pumping and heating units used in conjunction with the Wallsend-Howden pressure system of oil burning. A feature of the new design is the increased accessibility of all parts of both the pump, heater and steamers. Three furnace fronts arranged for burning oil on the pressure system under forced draught were shown, and the means adopted for quickly changing over to coal or *vice versâ* demonstrated. An arrangement of this kind is shown by the accompanying drawing, Fig. 76. This type of front has the central burner, and the work of conversion is simple and quickly carried out. It is especially recommended for use where a short time is available for the change over from coal to oil. When only oil is likely to be burned the air valves are specially designed for oil fuel alone and a somewhat simpler arrangement becomes possible. Two furnace fronts arranged for the pressure system with natural draught were also exhibited, with the central burner without fire-bars and the upper burner for working, if necessary, with the fire-bars in position. A further example showing the steam jet system was on view, as was also the new Wallsend low-pressure air burner, which has been applied with success for furnace heating and for cooking galley work. In this case the oil is atomised by low-pressure air supplied by a blower at from 6in. to 25in. water gauge, depending on circumstances.

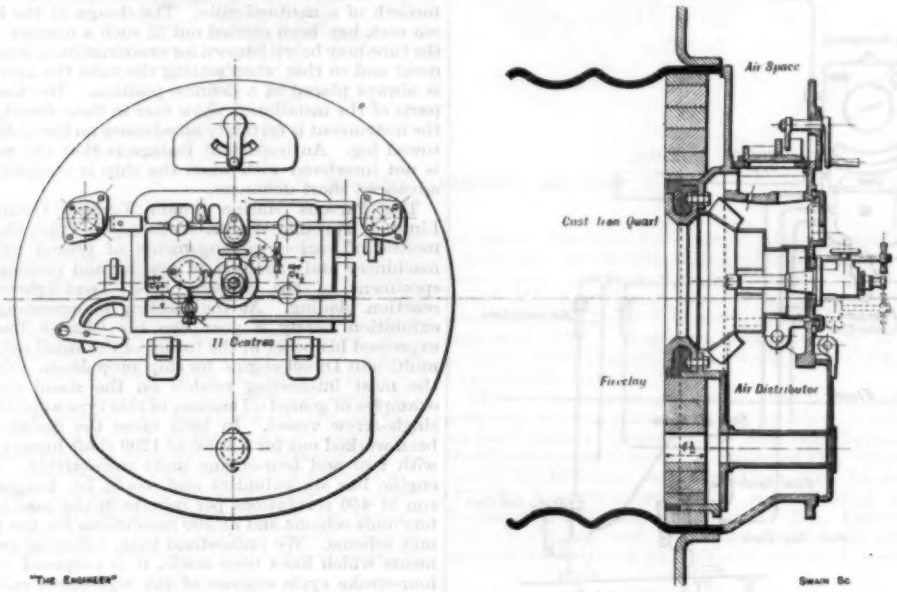


FIG. 76—WALLSEND FUEL BURNER APPLIED TO A BOILER FURNACE

Drummond Brothers, Limited, of Guildford, were represented by a well-arranged group of the firm's specialities, including the 3 brake horse-power "Willing Worker" paraffin engine and a number of auxiliary machines designed for use with it. Chief among these was a concrete mixer of the barrel container type arranged for belt driving. The working parts are robust in design and well protected from dust and dirt. It has a capacity of from 3 to 8 cubic yards of concrete per hour, according to the materials used. The pumping machinery shown included a diaphragm pump designed to deal with quantities of water up to 5000 gallons per hour. A suction pipe of 4in. in diameter is used with a rubber-faced ball valve and suction bucket. The drive is taken from the engine by belt to a reduction gear through fast and loose pulleys and thence by connecting-rod to the pump operating lever. Another pump shown was a duplex force pump designed for heads up to 100ft. and a capacity of 1000 gallons per hour. It is strongly constructed and well finished and rubber ball valves are supplied with it for use with dirty water. At 80 revolutions per minute the pump may be run on suction heads up to 25ft. For house lighting a neat installation comprising a "Willing Worker" engine with a belt-driven 1-kilowatt dynamo and switchboard, &c., was shown. A drag saw equipment for use with the engine we have mentioned was shown in use. It is portable and may be transported on its steel trolley. The saw blade is carried on a G frame built on hack saw lines, and with proper blades the machine may be used for steel as well as wood. An automatic shut-off device is fitted so that very little attention is needed.

Brown, Lennox and Co., Limited, of Pontypridd, South Wales, exhibited a wide range of mooring screws, chains, screw stoppers, swivels, and electric steel castings. The firm has specialised particularly in mooring screws and a complete model of a lighter, illustrating the way in which the screw is driven into the ocean bed, was a prominent feature on the stand. Among other interesting photographs were to be seen two originals showing Mr. I. K. Brunel at the launch of the Great Eastern, and alongside the 2¾in. cables which were manufactured in 1856 for that vessel by the firm.

Blackstone and Co., Limited, of Stamford and Central House, Kingsway, London, W.C. 2, had on their stand an exhibit which caused a good deal of attraction. This was a 4in. "Unchokable" pump driven by a Blackstone engine and complete with open circuit water tanks. The pump has been specially designed for lifting both hard and soft solids, and the main feature of the "Cormorant" impellor is that there is only one passage through it. All the parts of the pump are strongly built, and its capacity to deal with pieces of metal and stones was continuously demonstrated with success. Both horizontal and vertical pumps for high and low speeds are made, and particulars of them may be obtained from the Unchokeable Pump, Limited, 3, St. Helens-place, London, E.C. 3. The makers state that the 6in. pump will pass a stone 5in. in diameter.

James Pollak, Sons and Co., Limited, 3, Lloyd's-avenue, London, E.C. 3, showed on their stand a new "Bolinder" heavy oil engine of the two-cylinder direct reversible 60 brake horse-power type. In this new design both the fresh water drip and air injection have been discarded. A new type of fuel injection valve is employed. It is fitted on the top of the ignition bulb, so that the fuel is sprayed directly downwards towards the crown of the piston. The new valve is simple in construction, only three parts being used and no springs. A further improvement is a well-designed electric starting device, which enables the engine to be run up from cold in from fifteen to twenty seconds. It is provided with a quick-return screw handle, and when the engine has been started it may be withdrawn from the combustion space. Facilities are provided for inspecting all parts of the starter.

A prominent stand in the annexe was that of J. W. Brooke and Co., Limited, of Adrian Works, Lowestoft, on which was shown a representative selection of the various types of Brooke motor. Two boats were also exhibited, one a clinker-built general utility launch, 22ft. long by 5ft. 6in. beam and 2ft. 6in. deep, fitted with a two-cylinder 8 horse-power motor, and the other a 16ft. mahogany launch with a specially lightened Brooke Empire motor designed for a 15-knot speed. The series of large engines with cylinders 5½in. bore by 6in. stroke was represented by the two, four, and six-cylinder models designed to develop 20, 45, and 65 horse-power respectively, while the series of smaller engines with a bore of 3½in. and 4¾in. stroke included engines with from one up to six cylinders designed for from 4 to 25 horse-power. The 12 and 25 horse-power engines with three and six cylinders have been re-designed and a new type of cylinder fitted for use with either paraffin or petrol. A 1-kilowatt Brooklite electric lighting and power set was also shown.

Notable among the ships' auxiliary machinery was the full-sized working exhibit of the Donkin-Scott direct-acting electric steering gear shown on the stand of Laurence Scott and Co., Limited, of Norwich. We have already referred to the electrical part of the gear in our third article of September 14th, but the mechanical part of the gear made by Donkin and Co., Limited, of Newcastle-on-Tyne, deserves mention. The outstanding feature of the design of the gear is that the tiller is shrunk on and rigidly keyed to the rudder post, while the quadrant is loose on the same. Between the tiller and quadrant are interposed strong buffer springs which make an elastic connection and protect the quadrant and its worm drive from shock should heavy seas strike the rudder. A totally enclosed worm drive is employed with the gun-metal worm wheel integral with the pinion and furnished with ball thrust bearings. The motor drives the steel worm through a flexible coupling. All the gearing, together with the main motor, is mounted on a stout bed-plate, which in its turn is secured to a substantial cast iron sole plate bolted to the deck and so arranged that the worm and pinion gearing may be withdrawn from engagement with the quadrant should the emergency steering gear require to be used. A powerful grooved friction brake is provided, which enables the rudder to be firmly held while changing over from the main to the emergency gear. The principle of the spring-harnessed quadrant and tiller is recognised as an essential part of a reliable steering gear, and a very large number of such installations have been supplied for vessels of all types. The Atlantic Transport liner Minnewaska is fitted with the Donkin-Scott steering gear, as is also her sister ship Minnetonka, which will shortly be completed.

The Atlantic Engine Company (1920), Limited, Wishaw, Scotland, exhibited an extensive range of the petrol-paraffin marine type of engine which the company has developed. Among the four-cylinder units shown were the 14, 20, and 30 horse-power models complete with reversing gears and designed for speeds of 950 to 1000 revolutions per minute. The largest engine was a 70 horse-power six-cylinder unit with 6in. bore cylinders and an 8in. stroke. All the above-mentioned engines are fitted with a patented water-cooled lubricating system and automatic forced feed lubricators. Other features of the design are the enclosed fly-wheel, the detachable jacket heads, and the half compression cocks, with which all the larger engines are furnished. The lighting units made by the firm were represented by a 2-kilowatt yacht lighting set comprising a single-cylinder 4in. by 5in. Atlantic petrol-paraffin governed engine coupled directly to a Crompton dynamo and mounted on a substantial bed-plate.

Up in the gallery the Vikings-Tenax Company, of Colombia House, Regent-street, London, had a stand on which there was displayed a number of files reconditioned by a new process, particulars of which we failed to elicit from the company's representatives. We, however, took a couple of old files to be put through the process and found that, although the files chosen had been subjected to very hard usage in the past, they had a good "bite" again and had not lost any of their temper. The company claims that files, after they have dealt with them, have a useful life of from 70 to 90 per cent. of their original value.

Railway Matters.

The resumption of railway traffic over King's Ferry Bridge, Isle of Sheppey, which was to have taken place on Monday last, has been postponed for a month.

The death is announced of Mr. H. Copperthwaite, who was, for many years, the engineer of the southern division of the North-Eastern Railway and retired in 1898.

On the morning of October 1st trains crossed the Johore causeway connecting Singapore Island with the mainland. The length of the causeway is 3465ft., and there is a lock for small craft at the Johore end.

An objection raised by some shareholders in the Midland and South Junction Railway against the terms for its absorption by the Great Western Railway, was overruled by the Railway Amalgamation Tribunal on Friday last.

A statement issued by the Federation of British Industries states that the reduction of railway rates, made at the beginning of August, has been followed by satisfactory assurances as to flat rates. The Federation's proposed proceedings against the companies have, therefore, been withdrawn.

The reduction in fares made on January 1st last, led to the passenger receipts for British railways being 18.6 per cent. lower in April, 1923, than in April, 1922, despite an increase of 4.2 per cent. in the number of passenger journeys. Against this reduction was an advance of 7.3 per cent. in the passenger train-miles.

We notice that the third-class carriages on the Great Western Railway are now being provided with a circular arm rest in substitution of one under the whole length of the window. The new rest is evidently sufficient for a support for the arm and, different from the usual rest, does not press into a passenger's side.

During the first three months of the present year, two passengers were killed and 563 injured in train accidents in the United States, and 91 servants were killed and 558 injured. In the corresponding three months of 1922, seven passengers were killed and 351 injured, and 42 servants were killed and 342 injured.

The Mansion House Association on Railway and Canal Traffic for the United Kingdom has prepared for the guidance of its members a specimen form for lodging of objections with the Railway Rates Tribunal against the new schedules of standard charges. It will also co-ordinate all objections sent through the Association.

We are glad to hear that the fifty new cars being brought into use on the Metropolitan District Railway are to have more cross seats, and that special attention has been given to their smooth running. Experienced travellers will appreciate the former, as they give them support to the back. The smoother running will, no doubt, reduce the objectionable amount of oscillation.

The *Great Western Railway Magazine* for October states:—"Many people are asking what will be done if, and when, the standard scales (for season tickets) are sanctioned by the Tribunal. Will the companies at once put up their rates, or will they maintain the present charges? So far as the Great Western Railway is concerned, the answer is that if the decision is in their hands the directors will be very definitely opposed to any increase."

The "Sunny South Special" between Liverpool, Manchester, Birmingham and Brighton and Eastbourne, is a very old institution. It has, however, now a rival. In conjunction with the Great Western there opened, on Monday last, a service from Wolverhampton and Birmingham—with connections from Birkenhead and Chester—to Reading, whence coaches run *viâ* Guildford to Redhill Junction and on then to Brighton. Last year, it may be remembered, a through train was put on between Salisbury and Brighton, which gives through communication from South Wales, Bristol and Exeter.

A correspondent, addressing his letter from the Reform Club, wrote to *The Times* lately pointing out that in an excursion train from King's Cross to Lancashire and Yorkshire towns, there were fourteen first-class compartments, all of them empty. He observed that "apparently the railway managers are determined not to issue first-class excursion tickets and prefer to run the compartments empty." We do not know why these first-class compartments were on the train, but suggest that the railway company was short at the time of all-third-class carriages, and so pressed composite carriages into service.

The Rumanian Minister of Public Communications recently made a statement on the present deficient railway transport facilities in the country. He recognised that railway transport in Transylvania left much to be desired, but said that the difficulties were due to the fact that the former Hungarian State Railways planned Transylvania's railway system in such a manner that traffic gravitated towards Fiume and Budapest. The Government wished to remedy this defect by building new lines and connecting Transylvania's railway system with that of the old Rumanian kingdom, gravitating towards Bucharest and the Rumanian ports of Constanza, Galatz and Braila. New lines, he added, would also be built to Bucovina and Bessarabia.

It is seventy years ago to-day—October 5th—since the first serious railway accident in the United Kingdom occurred. This was at Stroffan, on the Great Southern and Western of Ireland, when fifteen passengers were killed. The engine of an express passenger train from Cork to Dublin broke down. It was dusk at the time. The guard went back to protect his train, but the driver, thinking he would be able to start, whistled his recall. The line was straight for 3½ miles, but the only protection was a dim light from a badly trimmed tail lamp. A passenger, recognising the danger, went and put the signal at Stroffan station to "stop," but this, the Board of Trade report said, was of no avail, as it led the driver of a following goods train to assume that the preceding train was at the next station. He, therefore, continued his journey and did not see the standing train until too late to prevent a serious collision.

Notes and Memoranda.

By means of a pitometer survey of the water mains in Detriot, leaks involving a total waste of 9½ million gallons a day were discovered.

It is said that the deposit of silver ore recently discovered in Australia at Cloncurry contains as much as 2000 oz. of silver per ton, with from 50 to 60 per cent. of lead.

A note in the *Chemical Trade Journal* mentions an electric motor which has been at work continuously for twenty-seven years. It is of 15 horse-power, runs at 1200 revolutions per minute and works on a 500-volt three-phase circuit.

A report from Beira, South Africa, states that tests carried out, under the supervision of Government engineers, on samples from the Zambesi Basin have proved the coal to be of fair quality, with an ash content of 12 to 13 per cent. and volatiles 24 per cent.

According to the preliminary report on the mineral production of Canada, compiled by the Dominion Bureau of Statistics, the total asbestos mined during the first six months of 1923 amounted to 1,482,102 tons, of which 1,297,243 tons, or 87.5 per cent. was milled. Sales advanced to a total of 99,042 tons, valued at 3,574,762 dollars, as compared with sales of 54,846 tons, valued at 1,894,232 dollars in the corresponding period of 1922.

According to Major U. P. Swinburne, the Chief Inspector of Mines in South Africa, earth tremors are becoming more marked on the Rand, owing to the increasing depth of the mine workings. The gradual settling down of the workings in exhausted and worked-out outcrop mines is, no doubt, the cause of these tremors, and there seems no reason to fear that the process will not continue with comparative immunity from loss of life and property.

A technical paper recently issued by the Chief Engineer with the Railway Board, India, gives detailed descriptions of many kinds of timber grown in that country, together with coloured illustrations. In the introduction the author, Mr. F. W. Allum, says that the only certain method of identifying a timber is to examine a cross section of it with a hand lens, and note the actual structure of the wood. Sufficient difference can be seen by this method to distinguish easily some of the more commonly used hard woods.

The Building Research Board of the Research Department has issued, as Special Report No. 7, accounts of the tests carried out at the National Physical Laboratory on the heat transmitted through walls of various types. These tests show that a solid gravel concrete wall and a wall of sand-lime bricks transmit about the same amount of heat under the same conditions, but that a wall of stock bricks only transmits about three-quarters as much heat. A cavity wall of ordinary type transmits about half to five-eighths that of a solid wall, according to the size of the cavity.

In the process of making some survey observations on the north shore of the St. Lawrence from the south or Gaspé coast, it was found that the straight line, about 80 miles long, between the two points passed under the surface of the water. It was impossible to use higher towers, and on several clear nights tests showed that the lights were invisible. Then came several nights when the conditions of refraction were abnormal, and when, owing to the upward arching of the line of sight, the north and south shore lights became intervisible, and it was possible to complete the required angular measurements. Moreover, the refraction, when it conveniently bent the line perpendicularly, did not bend it horizontally.

Some interesting figures have been published in regard to the Chilean production of copper. Chile commenced to produce copper in the year 1601, and during the ensuing century produced a total amount of 4550 tons, in the eighteenth century this amount was increased to 62,000 tons, and again rose to 1,800,000 tons in the nineteenth century. For the twenty-two years of the present century over 1,200,000 tons have been produced. In the year 1876, the amount produced by Chile was 38.14 per cent. of the world's production, this percentage fell to 3.62 per cent. in 1906, but is now once again on the increase, and at present stands at 15–20 per cent. Exports of bar copper from Chile up to May 31st last amounted to 67,345 tons, or say, an increase of more or less 21,247 tons, as compared with the same period last year.

Since 1916 a series of investigations into the deterioration of structures of timber, metal and concrete in sea-water has been undertaken by a Committee of the Institution of Civil Engineers with the aid of grants from the Department of Scientific and Industrial Research. The first report of the Committee was published in 1920, and the second (interim) report in 1922. A further interim report has now been prepared dealing with subsequent work. The contents of the report include the following:—Report on the investigations to protect timber against teredo; reports on the work carried out at the Marine Biological Laboratory, Plymouth; general report on the creosoting and impregnation of timbers; general report on the protection of iron and steel from corrosion by preservative coatings; report on the influence of strain upon the incorrodibility of iron and steel.

The metal mining industry of the United States in 1922 showed an increase of more than 30 per cent. in the volume of work done, as compared with 1921. A total of 29,141,293 shifts of work were performed, an average of 276 workdays for each of the 105,697 men employed at the mines during the year. The average workdays per man during the previous year was 238 and the number of employees was 93,929. Men working underground numbered 62,782, and they performed 17,836,061 days of labour, an average of 284 days per man. Employees engaged in open-pit mining numbered 13,084 and worked 3,321,871 shifts, an average of 254 days per man. Men employed above ground in shops and yards numbered 29,831 and worked 7,983,361 shifts, an average of 268 workdays per man. Accidents reported to the Bureau of Mines show the death of 344 men and the injury of 26,080 in the metal mining industry, indicating a fatality rate of 3.54 per thousand.

Miscellanea.

The occasion when the Sullivan Machinery Company opened its new factory at Michigan was the fiftieth anniversary of the company's organisation. The new plant has been put up at a cost of a million dollars.

The Goldsmid Engineering Entrance Scholarship, of the value of £40 a year for three years, at University College, London, has been awarded to Mr. C. Murray, Ealing County School. Mr. O. Moody, Central Foundation Boys' School, was placed *proxime accessit*.

The fifteenth annual dinner of the Faraday House Old Students' Association will be held at the Hotel Cecil on Friday, October 19th. Mr. H. W. Miller, M.I.E.E., will be in the chair. Members of the Association may introduce guests, who need not necessarily be Faradians. Old students who are desirous of attending should make early application for tickets to the secretary, Faraday House, Southampton-row, London, W.C. 1.

We understand that Mr. R. F. Hindmarsh, M. Inst. C.E., chief engineer to the Tyne Improvement Commission, has accepted the invitation of the Council of the Institution of Civil Engineers, London, to deliver the Vernon Harcourt Lectures during the coming session to the students of the Institution of Civil Engineers, in London, Glasgow, Manchester and Newcastle-upon-Tyne. The subject of the lectures will be "River Training and Maintenance."

In a report to the Christchurch, New Zealand, City Council, Messrs. Charles B. Hawley and Co., of Washington, give details of the proposed hydro-electric development of the Waimakariri River at Otarama Gorge, near Christchurch. The proposition, as recommended by the engineers, would cost £838,600, and would provide an initial generating capacity of 15,000 kilowatts, with an increase to 22,500 kilowatts by the installation of additional equipment and with an ultimate capacity of 45,500 kilowatts.

An Empire Mining and Metallurgical Congress is to be held at the British Empire Exhibition in London during the first week of June, 1924. The Institution of Mining and Metallurgy, the Institution of Mining Engineers, the Institution of Petroleum Technologists, the Iron and Steel Institute, and the Institute of Metals, representing the scientific and technical interests of the mineral and metal industries, with the Mining Association of Great Britain and the National Federation of Iron and Steel Manufacturers, are co-operating as conveners of the Congress.

The National Office of Inventions and Industrial and Scientific Research, the Union of Electrical Syndicates, and the French Automobile Club are conducting experiments as to the practicability of the wider use of electrically driven vehicles. After having charged their accumulators, eighteen lorries and cars left Bellevue just outside Paris and drove round the suburbs. These trials will be continued for ten days. It is pointed out that there are now 180,000 electrically driven vehicles in the United States; 30,000 in Great Britain and 3000 in Italy. Since in France petrol is expensive and water power abundant, it is urged that the perfection of electrically driven cars would result in effecting a national economy.

Towards the end of last month there was completed at the yards of Augustin Normand, le Havre, the destroyer Enseigne Gabolde, which is the latest vessel of this class to be added to the French Fleet. In the official six-hour trials a speed of over 33.45 knots was attained, surpassing by about 2.5 knots the speed for which the vessel was designed. The Enseigne Gabolde has the following principal dimensions:—Length between perpendiculars, 82.076 m.; breadth, 8.210 m.; depth, 5.100 m.; with a displacement of 905 metric tons. The propelling machinery is of the Parsons turbine type, designed to develop 20,000 indicated horse-power, and steam is raised in Normand type boilers. The armament includes three 100 mm. guns and one of 75 mm., with two double torpedo tubes.

Canada's total trade for the twelve months ending August amounted in value to 1,893,000,000 dollars, showing an increase of 381,000,000 dollars over the preceding twelve months. The total trade with the Empire was 646,724,000 dollars, being an increase of 126,210,000 dollars, of which 25,000,000 dollars were in imports from the British Isles and 68,000,000 dollars in exports to the British Isles. The total trade with the United States was 1,013,000,000 dollars, representing an increase of 206,000,000 dollars, of which 110,000,000 dollars were in imports and 96,000,000 dollars in exports. Canadian exports to Australia during the twelve months totalled 20,740,000 dollars, being an increase of 7,145,000 dollars compared with the preceding twelve months. Exports to New Zealand totalled 10,595,000 dollars, being an increase of 5,762,000 dollars.

Work has now been started on the electric power station which is to supply the British Empire Exhibition with both driving power and light. The power station is itself to form one of the exhibits in the electrical and allied industries section of the Palace of Engineering. A special gallery is being built from which visitors will be able at all times to view the machinery at work. The British Electrical and Allied Manufacturers' Association decided that the products of its member firms could most effectively be displayed if seen actually working. The Association has accordingly assisted the consulting engineers in planning the power station on lines that will make it representative of some forty electrical manufacturing firms. The main features of the power station will be three 1500-kilowatt turbo-generators, supplied with steam from two different types of water-tube boilers. Each generator will be the work of a different firm, and in the same way the condensing plant, air filters, rotary converters, transformers, cooling towers, switchgear, batteries, and so on, will be of varying makes. In the main hall, though not actually in the power station, there will be exhibited a slow-speed steam set and a horizontal internal combustion set, each generating 300 kilowatts. These sets will be run under load on stands, and will be coupled up to the body of the plant through panels on the main switchboard. The whole of the electrical and allied engineering section has been organised by the B.E.A.M.A., and over 200 firms are participating in it.

ELECTRIC WINDING PLANT AT HILTON COLLIERIES.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, ENGINEERS, MANCHESTER.

(*For description see page 359*)

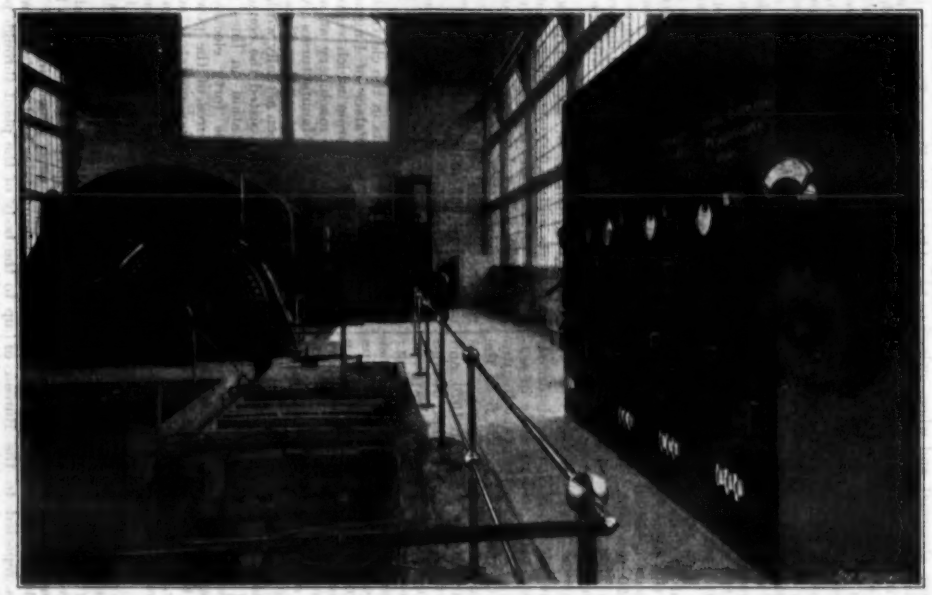


FIG. 64—WINDING ENGINE AND HIGH-TENSION CUBICLES

FIG. 65—FRONT VIEW OF EXTRA-HIGH-TENSION CUBICLES

FIG. 66—EXTRA-HIGH-TENSION SWITCHGEAR AND ELECTRICALLY-DRIVEN COMPRESSORS

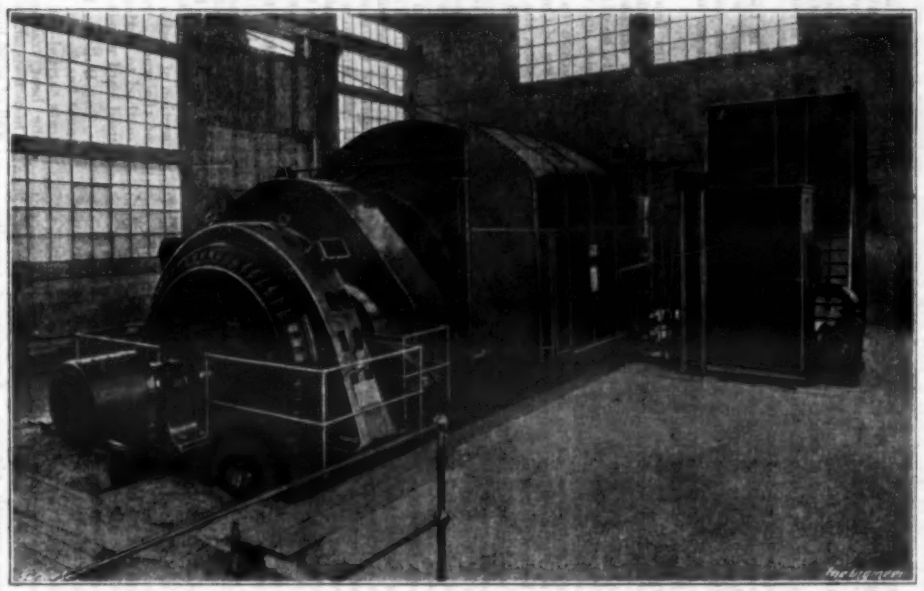


FIG. 67—WINDING ENGINE AND CONTROLLER

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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of The Engineer.

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*** All letters intended for insertion in* The Engineer *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

The Engineer, October 5th, 1923.	PAGE
A Seven-day Journal	357
Science and Industry in America.—No. IV.	358
Electricity in Mines.—No. X. (Illus.)	359
Varying Specific Heats and Gas Engine Mixtures. (Illus.)	361
Proposed Tunnel Under the River Mersey. (Illus.)	362
Sixty Years Ago	362
Canals Converted into Railways	362
The Shipping, Engineering and Machinery Exhibition.—No. VI. (Illus.)	363
Railway Matters	367
Notes and Memoranda	367
Miscellanea	367
Leading Articles—	
State Railways	369
The Locomotive Booster	370
British Association.—No. III.	370
Obituary—	
S. Pupleti	371
Literature	371
Books Received	371
British Commercial Gas Association	371
Boiler Feed-water Circuits in Power Stations. (Illus.)	372
The Ideal Seaport	374
Twin-screw Steamer Sarpedon	374
A New Dynamo and Battery Regulator. (Illus.)	375
Letters to the Editor—	
The Emigration of Workmen	375
Main Line Electrification	375
Multi-cylinder Locomotives	375
Launches and Trial Trips	375
Multiflow Steam Superheaters. (Illus.)	376
Provincial Letters—	
The Midlands and Staffordshire	377
Lancashire	377
Sheffield	378
North of England	378
Scotland	379
Wales and Adjoining Counties	379
Current Prices for Metals and Fuels	380
French Engineering Notes	381
British Patent Specifications. (Illus.)	381
Personal and Business Announcements	382
Forthcoming Engagements	382
Contracts	382

THE ENGINEER.

OCTOBER 5, 1923.

State Railways.

A decided change of view as to the State ownership of railways is gradually coming over most countries. A year ago the Conseil Superieur des Chemins de Fer in France gave a three-to-one vote in favour of its single State-owned railway being given back to private operation, in which the only public bodies to share were to be the Chambers of Commerce. In Italy the railways—certainly all the minor lines and possibly the major lines, too—are to be turned over, as practically a free gift, to company ownership. The only payment asked for is for the stores; for the track, rolling-stock and goodwill no charge is to be made. Moreover, the State will guarantee a minimum gross revenue per kilometre of line and will not expect to share in any profits until 7 per cent. dividend is being paid. In Belgium matters have not moved as quickly. But there the railways are to be put upon a commercial basis. Parliament is to have no voice in their administration, and a "Regie" is to be created to which their working is to be transferred. The Minister will remain, but only as a medium between the railway administration and the Government. He will regulate the issue of capital and present the railway budget, which first will be prepared by the administration and submitted to the Minister for his approval. Under the League of Nations, Sir William Acworth, in collaboration with Dr. Herold, one of the chief officials of the Swiss State Railways, has been investigating the problems of the Austrian railways, where an average of seventeen men were employed to every kilometre of railway. Commercial management is to be established, and it is said that Sir William is of opinion that if the people will support the new administration, their railways will be fully solvent in about two years' time. Of Germany it is, of course, difficult to forecast, even the immediate future, especially should her railways be operated as security against reparations. Lastly, there is Spain. Company ownership prevails there, but the State has immense power. The companies have long been in dire difficulties because they could not obtain consent to tariffs being raised to meet the higher pay of the men. It is beginning to be recognised that the situation urgently needs handling. Probably an increase in rates may be sanctioned, accompanied possibly by some sort of co-partnership between the companies and the Government.

The State ownership of British railways has now very few supporters. Their control by the Government from August, 1914, to August, 1921, killed the enthusiasm for nationalisation of railways, with that of mines and other public and semi-public services. Something may have to be done with the railways in the Irish Free State, but grouping is likely to be the remedy for their weakness. That is the wish of Mr. Cosgrave's Government. Were it rejected, the alternative would be that recommended by the Commission appointed by the then Provisional Government—see The Engineer of November 10th last—namely, that the Government should purchase the railways, but that they should be administered independently of the Government. Federal control of the United States railways killed State ownership there, too. The late President Harding, speaking in Kansas City on June 22nd, said: "The railroad question is no theoretical problem. When the Government undertook operation during the war and standardised wages and was caught in the sweeping current of mounting cost, it created a situation to ignore which would quickly develop a national menace. At an awful cost, we learned the extravagance and mounting burden of Government operation. Yet there are to-day very insistent advocates of Government ownership. Frankly, I do not share their views. Our political system has not reached a state of development when we can insure proper administration. I believe it would be a colossal blunder which would destroy initiative, infect us with political corruption, create regional jealousies and impose incalculable cost on the public treasury." It is only when countries need developing that their railway systems must, almost of necessity, be State owned. Such is the case in South Africa. As Sir E. H. Walton, the High Commissioner of the Union of South Africa, said at the Institute of Transport dinner last May, the country there had been developed by the railways. The rich lines provided the profit wherewith to build new railways, and when the latter, following on the development of the country, were paying, they, in turn, provided for new lines into undeveloped country. The ten to twelve thousand miles of railways could never have been constructed without a Government system of control and without such a system there never could have been the progress that had been made. We not only agree with the High Commissioner as to the wisdom of this policy in South Africa, but go further and say that the railways there set an example to all the State-owned systems in the world and to the majority of those company owned. The cause of this excellence does not, however, lie in the fact that South African railways are Government-owned, but in the ability of those who administer them and in the confidence shown by Governments, traders and the public in those at the head of railway affairs. So far for European, American and African railways. Let us now turn to those of India. In India, for the same reason that decided the question in South Africa, nearly all the railways are State owned. But though State owned, only three important lines—the North-Western, Oudh and Rohilkhand, and the Eastern Bengal—are State worked; the Bengal Nagpur, East Indian, Great Indian Peninsula, Bombay, Baroda and Central India, and the Madras and Southern Mahratta are company worked. A Committee, presided over by Sir William Acworth, which investigated the question of the future of Indian railways consisted of ten members. All were agreed that administration by companies of English domicile should not be continued after the termination of the existing contracts between the Secretary of State and the companies. They were also agreed that hybrid companies of English and Indian interests were impracticable. Five members, including the chairman, were in favour of direct State management, whilst the other five recommended a continuance of the existing conditions, with the proviso that the operating companies should be domiciled in India. It is important to note that the latter five consisted of two ex-Presidents of the Indian Railway Board, whilst one was a railway administrator, one represented European commercial interests in India, and one was an Indian commercial magnate. The report pointed out that three of the members of the Committee had no previous knowledge of India, and that three represented life-long experience on Indian railways. The three last named and one of the former three opposed State management. Many of the valuable recommendations unanimously made by the Committee have been adopted, but nothing has yet been announced as to the future administration of the company-managed railways. Broad-minded Indian business people consider that in conceding the establishment of companies domiciled in India, public opinion is being met, and they fear that State management would bring to India those evils which have been experienced elsewhere.

From this concise review of the present position,

it will be seen that in Europe and America State ownership of railways is dead or moribund, whilst in South Africa the conditions are such that no other course than State ownership is conceivable. In India the matter is still in the balance, but must soon be settled one way or the other, as the East Indian contract expires next year, and that of the Great Indian Peninsular in the year after. Opinion is pretty evenly divided between private and State management. There is no preponderating desire to see the management of the railways pass into the hands of the State, and with the example of France and particularly of America to weight the balance, it is likely, and for ourselves we trust it may, tip against that course. But the mere fact that opinion is so accurately divided is a significant fact. It shows, at least, that no preponderating advantages of State management were brought before the Acworth Commission. When there is no good cause for a change, wise men leave things as they are. Should the decision be of that order, then State ownership of railways and of many other things will have received a blow from which it will scarcely recover in a generation, if ever.

The Locomotive Booster.

THE experiment of fitting one of the "Atlantic" type passenger engines on the London and North-Eastern Railway with a booster is one of the most interesting innovations which we have noted in connection with locomotive engineering for some time. The booster causes the trailing wheels to act as driving wheels when starting, or when it is necessary to get over hard pulls on the road, and when it is considered just what that means it will be surprising if more is not seen of this adjunct to the modern locomotive.

One of the inherent features of locomotives having high sustained power capacity, is the great size of the boiler compared with the adhesive weight; the result is that wheels must be employed which are simply carriers, and which support the "idle weight," that is to say, weight which is not available for adhesion. The "Atlantic," or four-coupled engine, type is an example of a locomotive having the above characteristics. Because of its boiler power it can haul at speed trains within the capacity of six-coupled engines; but it experiences difficulty in starting them, and on stiff grades leaves something to be desired. By adding the booster and employing the weight borne by the trailing carrying wheels the effect of the six-coupled engine is attained. Hence, the loading which is restricted, not because of the engine's inability to haul quite heavy trains over the greater part of a division, but because some difficult gradient must be encountered, may be increased, and the much larger engines which have been detailed for the work may be withdrawn. Such conditions as we have outlined exist on many railways, and if the experiments being made on the Great Northern section of the London and North-Eastern line are successful, and we cannot see any reason why they should not be, there is reason to expect that the use of the booster will be greatly extended. But goods engines as now usually employed in this country are not of designs which lend themselves to the adoption of the type of booster used by Mr. Gresley, nor are we sure, at the present stage, that the application of a booster to the "train engine" as a means of negotiating steep grades with maximum loads would be entirely desirable; we are inclined to think the safer plan is still to assist in the rear until such times as we can have modern wagon stock. Yet we are inclined to think that the booster will find its greatest field of usefulness in goods train service, and on the time arriving when it is desirable to run trains faster, it is probable that freight engines of a different type from those in service at present will be required in order that greater steaming capacity may be attained. We would suggest a design having a leading two-wheeled truck, six coupled wheels, 5ft. in diameter, and a pair of carriers under the trailing end fitted with the booster. The design would have three cylinders and on the more level portions of the road, and at speed, would do all that the present eight-coupled designs can do. But it would have a better boiler, and the booster would largely obviate "banking assistance," and give at the same time starting power equal to that of the eight-coupled locomotive. In the meantime, assuming that a booster is required, then we can fit the same device in a modified form to the tender and get equal results. Such a booster has been tried on the Delaware and Hudson Railroad with, we believe, success, and is of particular interest, calling to mind, as it does, the Sturrock steam tenders of fifty-eight years ago.

Electrification has often been mentioned as being a method of solving the problem of short stiff grades encountered, perhaps, in the centre of what is otherwise an easy division, or of dealing with traffic on sections having more or less steep ruling gradients. While we are not prepared to say that the application of the locomotive booster would in all and every case be a better substitute, we must at least observe that the invention of the booster, as applied to the steam locomotive, is only another indication of the adaptability of the old machine to suit modern conditions, and that those responsible for it have not yet given up ideas of its further development. The booster affords, in our view, a simple and effective means of extending the sphere of usefulness of the steam locomotive, and if Mr. Gresley's experiment proves that locomotives designed twenty years ago can, by the fitting of the booster, be made suitable to tackle modern loads, the proposition is certainly attractive from more than one point of view.

British Association.

No. III.*

Squirrel-cage Induction Motor.

BEFORE Section G of the Association Dr. T. F. Wall gave an account of a new type of squirrel-cage motor which, he claimed, satisfied the conditions of high starting torque and low starting current on the line. He pointed out that one of the oldest outstanding problems in heavy current electrical engineering was the production of a motor of a type possessing those qualities which would at the same time retain the inherent characteristics of the standard squirrel-cage motor and possess the merits of cheapness, robustness, simplicity, and lack of risk of sparking at the rotor. In the type of motor, with the development of which he had been associated, the rotor conductors had the inherent property of a relatively high resistance when alternating current of 50 frequency flowed in them, whereas when the currents had the very low frequency corresponding to the rotor slip the resistance was practically the same as that given by direct-current measurement. In other words, the inherent resistance of the rotor conductors was proportional to the frequency of the alternating current which flowed in them. An advantage of the new motor was reduced cost as compared with the combination of a standard squirrel-cage motor and the necessary centrifugal clutch or other starting device to enable the standard squirrel-cage motor to start up light. Cost of upkeep was also reduced owing to the absence of slip rings and brushes. Further advantages were high power factor at full load and a general increase of efficiency.

The Teaching of Dynamics.

An interesting discussion would have taken place between the members of Section G and Section L on the Stroud system of teaching dynamics if time had permitted. There was a large attendance at the joint meeting, and a number of those well qualified to speak would have taken part in the debate, and it was to be regretted that the crowded character of the programme made any serious discussion impossible.

Sir James Henderson, who opened the debate, was, however, given sufficient time to deal with the Stroud system. He said that although the number of systems of teaching dynamics was considerable, the results attained were deplorable if tested by the knowledge possessed by the average young engineer. Teachers were either biassed in favour of the Gaussian system or the Perry system, and were loth to change their methods. Mistakes at that stage of an engineer's career cost nothing, but when he went into practice the value of accuracy was at once recognised. In the attainment of accuracy—not only numerical, but accuracy which made it certain that every factor in the problem had been considered—the Stroud system was a valuable aid. It was not, of course, new, and indeed it was taught by Professor Stroud until his retirement. The full system in all its essentials had not yet, however, been published. He (Sir James Henderson) had adopted it, but did not appreciate its full value until he joined the staff of the Royal Naval College in 1905 and discovered that advanced classes of lieutenants who had been trained for years on the Gaussian system were unable to solve practical problems in dynamics with ease or certainty. That trouble had been overcome by the adoption of the Stroud system. It was a common experience in laboratories and in the drawing-offices and test houses of commercial firms for a worker to present a result which was palpably wrong owing to the omission of one of his measurements. One great advantage of the Stroud system was that it made such an omission impossible. The great difficulty in teaching dynamics arose from the fact that the terminology was one of everyday use, and a student was handicapped by preconceived ideas as to the physical meaning of the terms employed. It should be the effort of every teacher to make the students think of the scientific definition of the term whenever he wrote a term down. The Stroud system did that automatically. Another advantage was that it enabled the experimental worker to shorten his calculations by employing mixed units without reducing them all to the ft.-lb.-sec. or cm.-grm.-sec. systems. If one factor was measured in millimetres and another in feet, depending upon the measuring instruments employed, these were so entered in the equation.

The discussion, although, as already intimated, curtailed for want of time, revealed general agreement as to the merits of the Stroud system. The reluctance to use it has, it was pointed out by Professor E. H. Neville, arisen largely from the misconception of the meaning of multiplication and division.

Mercury Arc Rectifiers.

The need for a simple stationary converter which could be compared with the static transformer was the subject of a contribution by Mr. R. L. Morrison.

It could be claimed, he said, that the high efficiency of the mercury arc when supplying direct current at high pressures rendered it particularly suitable for use in connection with railway electrification work. Single and polyphase rectifiers were used and special transformers were employed so that both halves of the alternating-current wave could be utilised. In the case of large rectifiers—the construction of which was described—the author pointed out that special means of sealing must be adopted to prevent the ingress of air. Care must be bestowed on the anode material, which had an important effect on the continuous operation of the plant. Experience of the use of the rectifiers for supplying high-tension direct current had been gained with those at work on the French Midi Railway system. It could be claimed that this type of rectifier possessed many advantages.

Professor E. W. Marchant agreed with the author as to the advantages of the mercury arc rectifier, which had the merit of simplicity of construction and an absence of rotating parts. The only difficulty which had been experienced in the use of this type of rectifier at Garston was due to sudden short-circuits, but he believed that that risk had been eliminated in more recent designs. Reference had been made by the author to the excellent field for the device in traction work, and the fact that its efficiency increased with increase of load certainly suggested its usefulness in railway work.

Mr. E. M. Hollingworth thought that the claims made for the mercury arc rectifier were too large. In the form of small units for battery charging purposes it should find considerable application, but he believed that for direct-current voltages below 1500 the rotary converter was to be preferred.

Professor Howe expressed doubt whether all the difficulties which had caused troubles in the earlier types of mercury arc rectifiers had yet been overcome, and referred to trouble which had been experienced at Glasgow.

The author, in reply, said the rectifier installation at Glasgow was the first of that size to be put in operation. At Garston the trouble experienced had been overcome by the fitting of new anodes. With regard to the cost of these rectifiers, it was a little higher in some cases than that of rotary converters, but for high voltages the cost was generally lower. On the question of efficiency the figures given in the paper showed that the mercury vapour rectifier was to be preferred in practically every case for direct-current voltages exceeding 400, except where induction regulators had to be used.

Visits to Works.

An interesting programme of visits to works and excursions had been arranged by the local committee. In addition, an exhibition of scientific apparatus was held at the Technical College during the period of the meeting, and on the evening of September 13th, when a *soirée* was held at the University, a series of lecturettes and demonstrations was given and an opportunity was provided for inspecting a collection of scientific apparatus in the various laboratories.

The visit to the Gladstone Dock works attracted a large attendance. It will be recalled that one of the features of this scheme is the river entrance to the new dock system. This entrance, which is over 1000ft. in length by 100ft. in width, will not only receive the largest ships afloat at high tide, but will at nearly all periods enable ships of 28ft. draught to lock-in, a somewhat remarkable feat in a river where the tidal range often exceeds 30ft. The graving dock, which is 1050ft. long with a width of 120ft., has been designed for use either as a dry or wet dock. The new Gladstone Dock system, when completed, will add 2¾ miles of quay to the accommodation of the port of Liverpool.

Another visit which presented features of special interest was that to the Aluminium Corporation works at Dolgarrog—see THE ENGINEER, February 25th, 1921, and May 25th, 1923. These works contain plant of a total capacity of 5580 kilowatts, and under the scheme which is being carried out in conjunction with the North Wales Power Company

* No. II. appeared September 28th.

a new power station with a capacity of at least 30,000 kilowatts will be built at Dolgarrog. Two 5000-kilowatt sets are now on order and a new pipe line is about to be constructed. These sets will generate at 6600 volts, stepping up to 35,000 volts for transmission. Proposals are now receiving consideration for a 110,000-volts transmission scheme to form part of a main ring system connecting Dolgarrog station with the proposed Maentwrog station, with the object of supplying power in bulk to the eastern area of the North Wales and South Cheshire electricity districts.

Arrangements were also made for an inspection of the Lake Vyrnwy section of the Liverpool Corporation Waterworks. There is now in course of construction a new tunnel between Marchnant and Hirnant Valleys, which will form part of the alternative draw-off from Lake Vyrnwy. Water will be drawn from the lake by the existing flood water discharge pipe in the north-east culvert of the dam. It will be conveyed by reinforced concrete or steel mains up to a point near the top of the Marchnant Valley, whence a tunnel will be driven through the mountains. The tunnel, which will have a length of 3337 yards and a diameter of 7ft., will emerge in the Hirnant Valley in close proximity to the outlet of the existing Hirnant Tunnel and the commencement of the cast iron mains by which the water is carried to Prescot. Those who participated in this visit also had an opportunity of inspecting the new machinery for the production of wood wool which has been installed in the sawmill. The plant consists of two horizontal wood wool machines supplied by Messrs. John Pickles and Son, with cutters working on a face of 2ft. by 1ft. 8in. The wood wool as it comes from the machines is baled in a horizontal press. A vacuum drying plant for extracting moisture from the spruce timber used for making wood wool has recently been installed. The drying plant was constructed by Messrs. George Black.

Obituary.

SAMUEL PUPLETT.

The death is announced as having taken place, in Clapham Park, on September 30th, of Mr. Samuel Puplett, of 47, Victoria-street, Westminster. Mr. Puplett had no special training as an engineer, yet at the age of twenty-seven he was manager of a works employing 1100 men. Later in life he specialised in refrigerating machinery and continued to do so until his death, which occurred when he was in his seventy-ninth year. Mr. Puplett had been a member of the Institution of Mechanical Engineers since 1884.

Literature.

Statistical Bibliography in Relation to the Growth of Modern Civilisation. By E. Wyndham Hulme, B.A. Grafton and Co. 1923. 6s. net.

The author was formerly librarian of H.M. Patent Office, and he has garnered the fruits of his long experience there in these pages, which form a portion of four lectures delivered by him at Cambridge in 1921 as Sandars Reader in Bibliography.

Basing his thesis on the doctrine that the fabric of modern civilisation is essentially artificial—"organic heredity has produced the human animal, but social heredity has produced the modern social man"—the author has sought in bibliography, the science of the organisation of recorded knowledge, a probe for uncovering the changes of activity in the human mind. The author first presents a classification of scientific manuscripts in the British Isles prior to 1500, revealing the fact that half the items are of medical import. He gives next Tabular Surveys of the literature of Architecture and Textile Industries respectively, and draws the conclusion that in the latter case the literature was not a ha'porth of use to anyone, and in the case of architecture it was by no means an unmixed blessing.

Turning then to English patent statistics, where he is on much firmer ground, he shows by a graph from 1561 onwards that till 1765 there were nothing more than minute spurts at intervals. From 1765, which he advances as the date of the Industrial Revolution, he shows uninterrupted expansion till about 1910. Adumbrating that a peak must be reached, to be succeeded by the introduction of a new phase in civilisation, he places such peak at the date given, viz., 1910. He supports this by tabular statistics based on the "International Catalogue of Scientific Literature," tending to show that we are now faced with a diminished output in science and invention, together with a decline in population.

Turning to the fields of engineering and industry, the author considers "that the age of Power is approaching its natural limits," and "that a strong undercurrent has set in which translates the higher efficiency of our industrial processes into terms of higher costs of production." He concludes that the industrial future must be based on the replacement of a mineral basis by one founded on the replaceable natural sources of energy and upon the synthesis of needed raw materials or commodities.

The impression gathered from the study of this book is that of inconclusiveness; there are too many factors and variables involved; the period over which accurate knowledge is available is very brief; human progress cannot be imagined to be so simple as a wave motion or pendulum swing, nor yet as a flight of steps of unequal treads and risers. In short, the author has endeavoured to extract from his materials conclusions which, however sound generally, are, it seems to us, hardly deducible from his evidence. Yet the idea that is presented here of investigating statistically the output of human thought is a new and original one, and will suggest to the investigator fresh lines of attack in the domain of historical research.

The Railways of Spain. By George L. Boag. London: *The Railway Gazette*, 33, Tothill-street, S.W. 1. 8¼in. by 5¼in., 127 pp. 12s.

From personal acquaintance with the author of this work we know that he speaks from several years' practical experience of Spanish railways, and that he takes a broad, generous view of the conditions only to be expected in Spain. On the second page one's sympathy for the troubles of the Spanish railways at once is won by the remark: "From whatever point one approaches the great central plateau of Castile there is a heavy climb, and the severe grades make high speeds impracticable. None of the main trunk lines have ever had a traffic sufficiently productive to warrant heavy expenditure on improved location, and the consequence is a general low average of speed. The unreflecting tourist, ignorant of these conditions, enters Spain from the level plains of France and casts quite unjustified criticisms on Spanish railway working." The lines have been constructed on a policy laid down in 1844, the authors of which were, by 1853, shown to be "far-seeing engineers" who "had already proved themselves true prophets." In 1877 a law was passed providing that maximum tariffs were to be fixed, subject to revision every five years, and if the Government insisted on a reduction it must also guarantee earnings equal to those of the preceding year, plus the average increase of the five years preceding. Railwaymen in Spain are well treated, and there has never been any difficulty in obtaining recruits for the service. At many of the large centres the companies maintain schools and institutes. There are properly constituted pension schemes, and one railway has a profit-sharing scheme. In the matter of rolling stock the Spanish railways can claim to be well in touch with the most modern practices. The finances are, however, in a bad state, and the author observes, "the simplest way out of the difficulty, and one that is most likely to commend itself to a Government overburdened with the present task of regularising the national finances, is to authorise a further increase in tariffs. A part of such increase will, undoubtedly, be earmarked for the men, and it may be that a further percentage will be ordered to be dedicated to new works." Among the subjects dealt with by Mr. Boag are statistics, rates and fares, permanent way, signalling, and rolling stock. There is a very good map, a diagram of maximum engine loads of the "rapide" trains, a gradient profile to show the contrast between the Paris-Irun line in France and the Irun-Madrid, diagrams of permanent way and signal details, of wheel arrangements and dimensions of engines, and photographs of engines, carriages and typical stations. The letterpress and illustrations are excellent.

BOOKS RECEIVED.

The Poulsen Arc Generator. By C. F. Elwell. London: Ernest Benn, Limited, 8, Bouverie-street, E.C. 4. Price 18s. net.

Concrete Roads. Second edition. London: Concrete Publications, Limited, 4, Catherine-street, Aldwych, W.C. 2. Price 5s. net.

Gas Manufacture. By W. B. Davidson. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 21s. net.

Engineering Kinematics. By W. G. Smith. London: The McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 15s. net.

British Commercial Gas Association

A very large attendance was secured for the annual general meeting of the British Commercial Gas Association which was held at Birmingham on October 1st, 2nd and 3rd, under the presidency of Mr. John Henry Lloyd, chairman of the City of Birmingham Gas Committee.

It was pointed out in the annual report of the Association that the statistics of the sales of gas refuted the idea entertained in some quarters that the gas industry was declining. The increase in the sales of gas for the decade 1913–1922 was 60,000 million cubic feet, compared with 45,600 million in the preceding ten years.

Mr. J. R. Clynes, President of the National Union of General Workers, which includes the unions connected with the gas industry, made a powerful plea for co-operation in industry, so that the level of output and general efficiency could be raised. Increased production must, he asserted, mean not merely greater commercial prosperity and profits, but an improved standard of life for the workman. The nation's margin of security depended on the maintenance and expansion of overseas trade. The biggest blunder that employers had made was that of seldom giving that which they could afford to give except under pressure of the worker's power to compel, and workmen, in many instances, still remained under the delusion that the less work they did the more there would be for others to do. England could no longer keep a place in the markets of the world if any system of under-production were tolerated. Workmen must broaden their outlook.

The technical aspects of the gas industry were mainly dealt with in a group of papers presented and discussed on Wednesday. The practical advantages of gas service to the manufacturer was raised by Mr. A. W. Smith, the general manager of the Birmingham Gas Department. It was stated in this contribution that during the twelve months ended March 31st last, the quantity of gas consumed for manufacturing and motive power purposes in Birmingham, amounted to 2,852,337,500 cubic feet, representing 26 per cent. of the total consumption. Manufacturers had realised that gas service offered the solution of various workshop problems, and to meet their requirements the Industrial Gas Section of the Birmingham Gas Department had been developed into a local National Physical Laboratory. In order to assure satisfactory service to the public, those associated with the management of the gas department had appointed a fitting engineer, whose duty it was periodically to examine the gas engines installed in the area, and for a nominal charge to indicate and keep them in an efficient condition. Those connected with the gas industry realised, said Mr. Smith, that the use of electricity for power had come to stay, and it was, indeed, adopted in up-to-date gasworks. There were, however, certain loads which the gas engine could deal with more economically, and even where conditions were such that electric motors formed a more convenient source of power, current could be generated at less cost by means of a gas engine works unit than the price of current taken from the town mains. In factories where sudden peak loads had to be met, gas engines had replaced motors which could not deal with a high momentary overload. The branches of industry in which gas was employed for heating and power requirements included motor car and cycle trades, lamp manufacture, tin-plate trade, the non-ferrous metals industry generally, glass trade, tube manufacture, steel pens, electro-plate and precious metals and jewellery.

Mr. C. M. Walter, the engineer-in-charge of the Industrial Research Laboratories of the gas department of the City, said that as a result of the improvements which had been effected during recent years temperatures up to 900 deg. Cent., which were suitable for a great variety of work, could be obtained even in some of the largest furnaces by the employment of town's gas at ordinary pressure by the use of some form of regeneration. The natural draught furnace was by far the most popular among manufacturers requiring temperatures not exceeding those used for case-hardening operations. Temperatures as high as 1900 deg. Cent. had been attained in specially designed natural draught furnaces fitted with recuperators, of which the "Revergen" furnace, manufactured by Radiation Limited, was an example. During the last few years special attention had been paid to the question of lagging, and by the employment of suitable material, evolved through experimental work, a reduction of 30 per cent. in heat losses had been achieved. For high working temperatures, from 1000 deg. to 1500 deg. Cent., the recuperative type of furnace could be utilised with advantage, no excessive air pressure being required; but for continuous working at 900 deg. Cent. some form of counter-current regenerator would give the most satisfactory results, and a good deal of work had been done by the Research Department in this field. Recently, in collaboration with Gibbons Bros., Limited, tests had been made using town gas in a modified form of counter generator. The object was to eliminate fittings and burners, and to burn the gas in bulk through fire-clay ports, similar to those used in an ordinary regenerative retort setting. A furnace of this type which appeared to possess great possibilities had been in operation at the National Gas Exhibition under working conditions. A similar furnace was being employed by the Moss Gear Company for the carburising of motor gears. The small direct-fired furnace was largely used for the hardening of carbon steel and high-speed tools and punches. For brazing operations in brass, steel and copper tube manufacture, a continuous type of furnace having a gradually increasing temperature up to the brazing zone was used. Some excellent furnaces had been installed in Birmingham works, replacing the older type of coal hearths. With falling prices for gas it was hoped, said Mr. Wilson, that its employment for heating purposes would be extended.

A large number of those attending the conference accepted the invitation of the Gas Committee to inspect the Saltley Gasworks, including the coke oven plant; the Nechells Gasworks, where a coal-testing plant is in operation; the Windsor-street works, where the high-pressure compressing plant and the heat treatment shops were seen, and the Industrial Research Laboratories.

Although there will be no need for some time to come to proceed with the erection of the new works at Washwood Heath, which will be designed for an output of 20,000,000 cubic feet per day, additional storage accommodation is required and two large three-lift telescopic gasholders, each of 5,900,000 cubic feet capacity, which can be enlarged to 10,000,000 cubic feet capacity, are now under construction on the new site.

Mr. H. Wade Deacon, chairman of the Liverpool Gas Company, has been approved as President-elect of the Association.

It may be of interest to recall that Mr. Richard Hazleton, who began his association with the Society of Technical Engineers last year, and who has now been appointed its secretary, was, for more than a decade, a member of Parliament for the constituencies of Louth and Galway. He served on many important committees during his time at Westminster, including the Public Accounts Committee of the House of Commons, the Prime Minister's Reconstruction Committee, and the Balfour of Burleigh Committee on Commercial and Industrial Policy.

Boiler Feed-water Circuits in Power Stations.*

By JAMES G. WEIR.

The function of the modern steam power station is to convert the maximum amount of the chemical energy of coal into electrical energy. In carrying out this process a working fluid or medium is used which, in a suitable cycle of operations, will absorb the heat of combustion of the coal and convert it into work energy which, in turn is converted into electrical energy. The working fluid

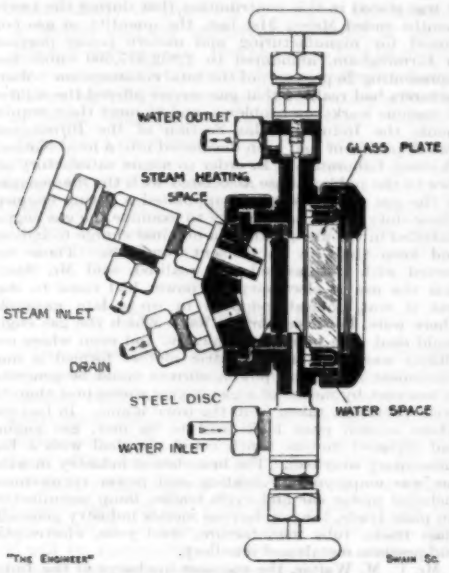


FIG. 1—THE WEIR CORROSION DETECTOR

or reagent, which is universally chosen for this purpose, is water. In a modern power installation, the cycle through which the water passes from the boiler to the condenser is accomplished very rapidly. If we exclude the water in the feed reservoir—which, by suitable arrangements, need not take part in the active circulation—the total weight of water and steam comprised in the cycle is not more than 10 per cent. of the amount circulated per hour. In other words, the complete cycle of operations

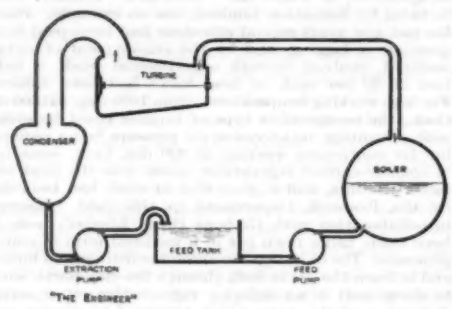


FIG. 2

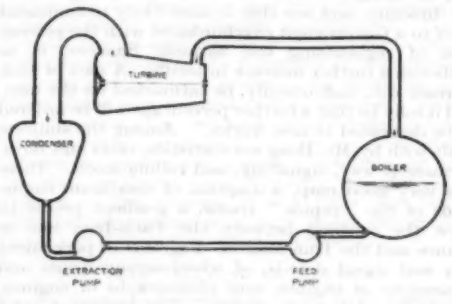


FIG. 3

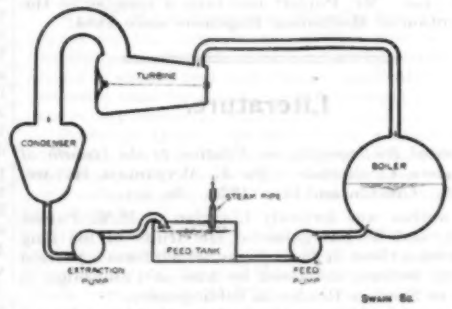


FIG. 4

is gone through ten times per hour by the water taking part in it. We thus see that modern conditions tend to reduce the actual amount of working fluid required in relation to the power produced, but at the same time place a heavy premium on its purity and chemical inertness. If the water is assumed to be initially pure, there are only three possible sources from which it can absorb impurity:—First, by the leakage into the system of condenser circulating water through defective tubes or packing; secondly, in the water supplied to make up losses by leakage out of the system; and thirdly, by absorption of air and other gases in the feed reservoir.

The contamination of feed water through the condenser is in many instances a source of great anxiety to the operating engineer, and in its results is probably one of the most costly of operation defects. It can be eliminated in most cases by careful packing and good workmanship and avoiding temperature changes caused by the admission of steam when the vacuum is not maintained. There remain a number of cases where the supply of circulating water is of a corrosive nature, such as is frequently found in river estuaries. In such cases the material of the condenser tubes must be chosen with specially high resistance to corrosion. Pure nickel or alloys with a high proportion of nickel would meet this requirement, but solid tubes of such material have not hitherto been available. I am able to state, however, that extremely promising results have lately been achieved in the production of solid drawn tubes of Monel metal. Should the present experiments result in the production of tubes on a commercial scale, it should afford a complete solution of this trouble. The second possible source of impurity in the system comes from the make-up feed supply. To meet the conditions we have described there can be no doubt that in modern high-pressure plants distilled water is essential. We now pass to the consideration of the third cause of contamination, namely, the absorption of air in the feed tank. Before discussing means by which this absorption may be avoided, let us briefly consider the characteristic properties as regards corrosion of water with and without air in solution.

Many years ago, my father, after many experiments, came to the following conclusions:—(1) Pure water is chemically inert with regard to steel or iron throughout the whole temperature range of modern boiler practice, provided no other materials, either gaseous or liquid, are present. (2) Water containing air in solution is chemically inert with regard to steel provided the temperature and pressure conditions are such as to maintain the air in solution. (3) If air be liberated from solution in water by raising the temperature or lowering the pressure of the latter, the oxygen thus liberated combines directly with iron, forming iron oxide (Fe O). Iron oxide forms a hard, adhesive, and protective coating, and stops further action. (4) If the reaction indicated in (3) takes place in the presence of CO_2, the latter combines at once with the FeO, forming Fe_2CO_3. This is soluble and is in turn oxidised by any oxygen present in the water liberating the CO_2 and permitting continuous corrosion to take place.

Many cases might be quoted of the operation of the principles outlined above. They show, for example, why corrosion occurs in a boiler but not in a condenser, and on the back of a propeller blade and not on its face; simply because the pressure-temperature conditions are such as to liberate the oxygen in the one case and not in the other.

In power station operation it becomes extremely important to determine the quality as regards corrosion of the water passing to the boilers, and for this purpose my father devised the instrument, based on the above principles, which he called the "corrosion detector." This instrument—illustrated in Fig. 1—is inserted in the feed range, so that the feed water is passed over one side of a polished steel disc, which is heated on the otherside by a current of steam. If the water contains corrosive gases in solution, these are released in their active condition and immediately attack the polished surface of the disc. The rapidity with which the attack takes place comes as a revelation to many engineers who visualise corrosion as a comparatively slow process. The instrument is simple in design and construction, and by its use the engineer in charge can keep a continuous watch on the condition of his feed system as regards corrosive effect. If in addition to this instrument an electrical salinometer is fitted, a complete record of the purity of the feed system can be obtained. Having determined, as the result of experiment and practical experience, that our working medium will be innocuous if it is pure and free from dissolved gases, we must now consider how this may best be achieved. There are obviously two alternative methods; we may prevent the access of air at all points of the feed circuit and introduce our make-up feed into the condenser, where it will be at once de-aerated, or else we may allow our feed water free contact with air and de-aerate it at a suitable point of the circuit before it has been put in the corrosive condition by the addition of heat. Both methods are workable, and each has its special field of application dependent on circumstances. The first method we termed the "closed" system, and the second method the "de-aeration" system.

The Closed System.

Taking the "closed" system first, we will briefly trace its development and indicate the difficulties to be overcome. Consider the simplest open feed circuit—Fig. 2. Suppose we close this circuit and prevent access of air by connecting the water extraction pump directly to the feed pump, as shown in Fig. 3. This, then, is an ideal circuit and has only one fault in operation; that is, there is no control on the quantity or the distribution of the water in the circuit. This is a serious matter in practice, as different rates of evaporation require different quantities of water in the boilers, and, moreover, any excess of water finding its way to the condenser might flood the latter if the boilers were, at the moment, not ready to receive this excess. Actually, an arrangement of this kind without a flexible water capacity is quite impracticable. Having failed to find a solution in directly closing the system, let us next retain our flexible water capacity by keeping the feed tank in the circuit, but try the effect of what has been termed "steam sealing" the feed tank, illustrated diagrammatically by Fig. 4. We have placed an air-tight cover on the feed tank and introduced a small steam pipe, so regulated, let us say, as to maintain a very slight positive pressure on top of the water surface to prevent leakage of air into the system.

This arrangement would appear to meet all requirements, but unfortunately, in practice, it will not behave as we wish. The trouble lies in the fact that if there is no air to act as an elastic cushion on top of the water surface in the feed tank, a water level cannot be maintained. In the absence of air very rapid condensation of the sealing steam takes place, and the tank, having once filled, becomes virtually no more than an enlarged portion of the pipe between the extraction pump and the feed pump, and we are reduced to the identical conditions of Fig. 3. Suppose, however, we modify our Fig. 3 arrangement by means of a standpipe and tank inserted in the circuit between water extraction pump and feed pump, as shown in Fig. 5. We may then regulate our boiler level by a control valve as indicated, and variations in the quantity of water in the circuit will be automatically compensated by the water level in the tank. There will be no circulation of water in the tank except to compensate for variations of load, consequently the water which is exposed to the absorption of air will only gradually enter the circuit. We have, therefore, in this arrangement, which is in fairly common use, found a partial solution of the problem. A complete solution is, however, possible, and the following diagram—Fig. 6—will illustrate the method. It is fundamentally the arrangement of Fig. 3, but an elasticity has been achieved by the use of an open feed tank external to the circuit itself, but coming into action automatically as required. It forms a source of feed water when a deficiency exists in the circuit and a reservoir for surplus feed when there is too much in the circuit. The distribution of water in the circuit is controlled by the water level in the boilers. Should there be too much water in the circuit, the water extraction pump withdraws it from the condenser, and as the feed pump is controlled in its delivery, an overflow valve between the water extraction and feed pump comes into action and allows the surplus water to escape out of the circuit into the external feed tank. Should the converse condition arise and the feed pump demand more water than is forthcoming from the condenser, the pressure between the two pumps falls and operates a valve which allows water to flow from the external tank into the condenser, where it is immediately de-aerated before entering the circuit. As a result of practical experience in the operation of plants arranged on this system, it has been found desirable to have an additional control on the admission and discharge of water from the closed circuit. This control is effected by floats in the base of the condenser, as shown in Fig. 8, and enables the system to work with less pressure variation between the water extraction and feed pump and with a definite stability and steadiness under all conditions of load.

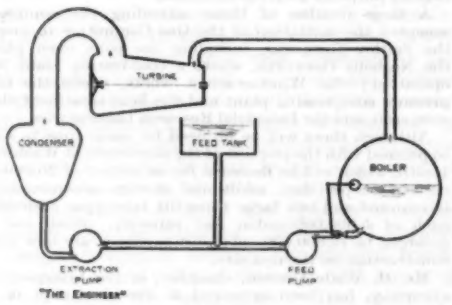


FIG. 5

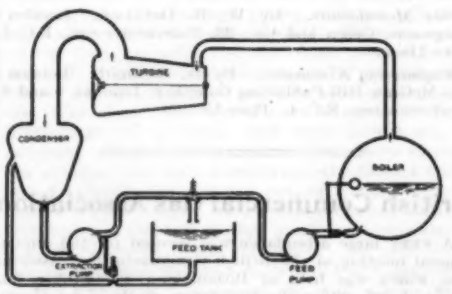


FIG. 6

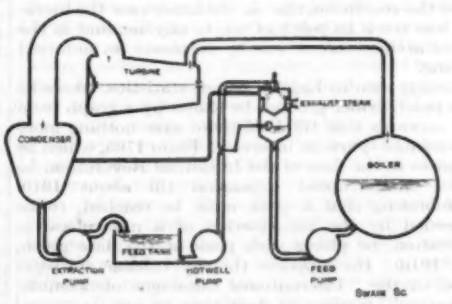


FIG. 7

* Read before the Koninklijke Institut van Ingenieurs in Holland, September 9th, 1923.—Abridged.

The De-aeration System.

Let us now consider the second alternative method of procuring an inert working fluid—the "de-aeration" system. In carrying out this method we do not attempt to isolate the feed water from contact with the air, but instead we extract the air from the water before it enters that portion of the circuit where it would otherwise be liberated and cause active corrosion. To do this we make use of the fact that, if water be boiled, its dissolved air is at once liberated. Further, this may be achieved at any pressure and corresponding temperature.

The simplest form of this type of installation is that with which the majority of steamships are equipped, namely, a direct contact feed heater and de-aerator of the Weir type—see Fig. 7.

Many very successful installations are now in operation with the various forms of de-aeration system just described. Tests with the corrosion detector—see Fig. 1—have shown a complete freedom from corrosive gases, and in some cases where the system has been applied to existing stations serious corrosion troubles previously occurring

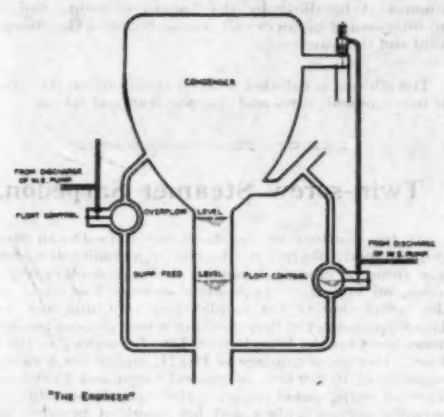


FIG. 8

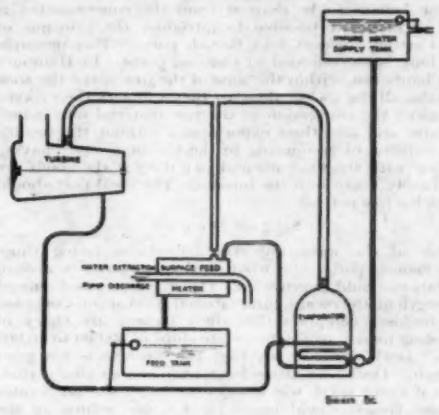


FIG. 9

have been definitely stopped. One of the advantages of the de-aeration system is the ease with which it can be applied to existing stations having open circuits. The method of application varies with the circumstances, but the arrangements shown in Figs. 10 and 11 show typical cases.

A careful study of the feed circuit as a whole will enable the general heat balance of any station to be more clearly appreciated. Regenerative principles can then be employed in connection with the furnace gases and exhaust steam to heat the air used for combustion and to heat the feed water so that it may be delivered to the boiler as near to the boiler temperature as possible. Fig. 9 shows a convenient method of coupling a low-pressure exhaust steam circuit to the main turbine, evaporator, and feed heater, so as to obtain automatic adjustment to the most economical conditions at all loads. At low loads the proportion of auxiliary exhaust steam to main steam is large, and accordingly the feed heater cannot condense the whole quantity; the surplus flows into the lower stages

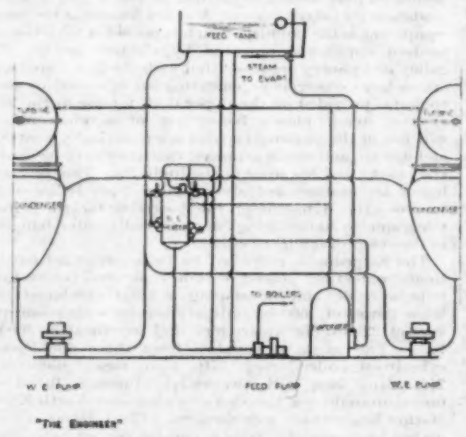


FIG. 10

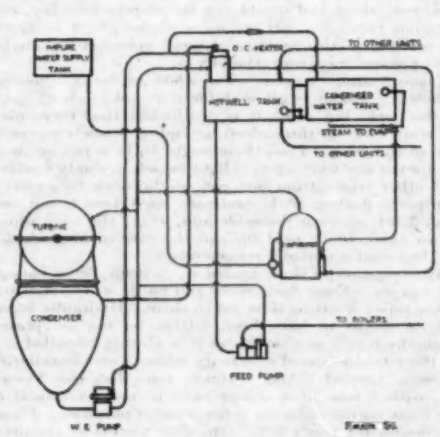


FIG. 11

of the main turbine, where it does useful work. At higher powers the conditions are reversed, and the feed water is capable of absorbing more heat than is available in the auxiliary exhaust. Steam then flows from the lower stages of the main turbine to make good the deficiency. This system has been in operation in many naval vessels, enabling excellent economy to be obtained under the widely different conditions of cruising and full power.

Regenerative Feed Heating.

The very high boiler pressures now employed are making feed heating in more than one step practically essential for good economy. This procedure calls for considerable care in the actual design and construction of the higher stage heaters. Tubular apparatus of the ordinary condenser type of construction is quite unsuitable. Freedom to expand and contract without stress is essential, and any joints between the water passages are a source of continuous trouble. The drawing reproduced in Fig. 12 shows a design of feed heater embodying those requirements, which has proved very reliable in service with pressures up to about 600 lb. per square inch. The tube surfaces are formed by heavy section large diameter copper pipes, which are entirely free from the defects of small diameter brass tubes. It is only by careful design that, as regards regenerative feed heating, the economies of theory can be realised in practice. Similarly, in other auxiliaries, it will be found that a saving in first cost is seldom warranted if efficiency or reliability are thereby sacrificed. It should be carefully noted that with stage feed heating to high temperatures we are virtually subdividing our boiler into compartments, and the feed heater becomes a part of the boiler. The potential energy contained in a high-pressure feed heater approaches that of the boiler itself. To generate steam at 500 lb. pressure from condensate at 80 deg. Fah. with full regenerative feed heating, requires an expenditure of 400 B.Th.U. in feed heating, and only 790 B.Th.U. in evaporation; that is to say, fully one-third of the heat transference is carried out outside the boiler. With the logical development of still higher pressures in steam practice, it is certain that the boiler proper, or steam generating portion of the feed circuit, will be relatively restricted in size and capacity, and will only contain a very limited amount of water. Similarly, in considering the conditions on the combustion side of the boiler circuit, we must alter our conception of the boiler as a self-contained unit, and we must now regard it as a chain of processes having a combustion chamber proper, in which a carefully regulated chemical process is carried out, and a series of heat exchange chambers, in which the heat gradients are carefully adjusted to avoid unnecessary loss of heat availability.

In considering the feed circuit and the functions of the working fluid in modern practice, it is evident that we are in a transition stage of development. The tendency towards higher steam pressures and temperatures has been for many years restrained by practical difficulties, such as we have been considering. The tendency, however, is quite sound in principle, and is fully justified on thermodynamic considerations. On the assumption of reversibility, the cycle efficiency of any heat engine is given by $\frac{T_1 - T_2}{T_1}$ where T_1 and T_2 are the respective absolute temperatures of reception and rejection of heat in the cycle. This expression is a fundamental one, and any increase of temperature range in the cycle is accompanied by a corresponding increase in economy. As our lower temperature limit is fixed, progress can only be made by increased initial temperatures. The other aspect of thermodynamic efficiency is that all the heat absorbed by the system should be taken in at the highest temperature of the cyclical process and rejected at the lowest temperature. This ideal is approached by way of regenerative systems of feed heating operating at various stages with the object of delivering the feed water to the boilers at the highest practicable temperature. As already indicated, the difficulties in practical feed heating have been successfully surmounted, and this method may now be fully exploited. There still remains, however, the irreversible heat drop between the flue gases and the steam which forms the basic source of inefficiency in the steam plant. The diagram, Fig. 13, shows broadly the conditions surrounding the transmission of heat through a boiler plate in a steam plant working at, say, 250 lb. pressure. The enormous drop between points A and B is noticeable. This drop indicates that the availability of the energy has been lost. With a potential absorption temperature of, say, 3500 deg. Fah. absolute, we are forced by the peculiar practical conditions in the normal boiler plant to absorb the bulk of that energy at a temperature in the neighbourhood of 800 deg. Fah. absolute. Although the range of temperature operating in the plant is, roughly, 3000 deg. Fah., the actual practical range of working—excluding superheating conditions—is more nearly 330 deg. Fah., and with superheating up to that of the best modern practice is, roughly, 500 deg. Fah., as is shown by the dotted lines. Comparing these conditions with those of an internal combustion engine, we find that in the latter, by a process analogous to feed heating in the steam cycle, a portion of the energy is tapped from the original supply and is transmitted during the cycle, by the piston and moving parts of the engine, to the working fluid. This process we term compression, and its immediate effect by

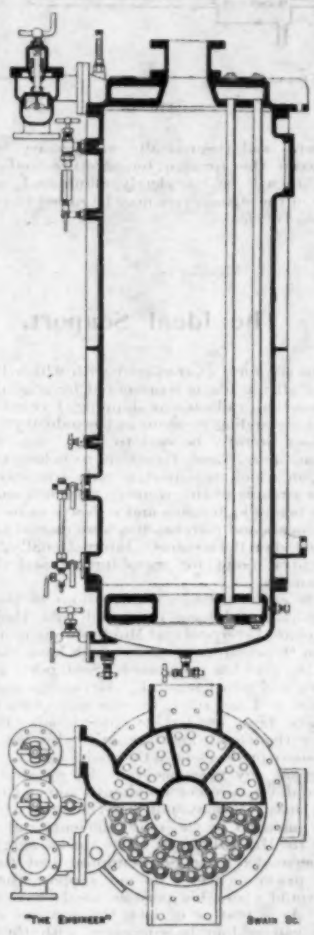
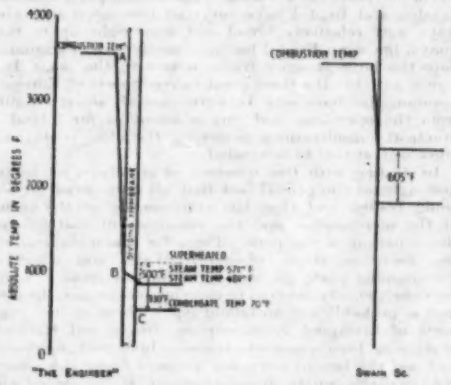


FIG. 12

raising the temperature of the working fluid is to elevate the temperature of absorption of energy. Assuming a compression temperature of, say, 1450 deg. Fah. absolute, and an explosion temperature of, say, 3500 deg., we might roughly indicate the conditions by Fig. 14. In this case the bulk of the heat is absorbed at, say, 2500 deg., and the range of temperature is over 600 deg. The problem before the steam power plant designer is, therefore, clear. If we can use Diesel temperatures in steam practice, we shall achieve at least Diesel efficiencies. The broad principles apply to both cycles—the basic difference is in the working fluid. In the internal combustion engine we use the products of combustion which have many undesirable features, and,



FIGS. 13 AND 14

under normal conditions, the types of fuel which may be used are severely restricted. In the steam cycle we use a medium under complete control and capable, under correct treatment, of exhibiting practically ideal properties. We find also a remarkable elasticity in the type of fuel employable. In Fig. 15 we have shown diagrammatically the combined combustion and evaporation cycle of a steam plant. The air for combustion is regeneratively heated by the products of combustion leaving the steam generator, and the feed water is regeneratively heated in the steam cycle. If the entropy diagram for the combustion or air portion of the cycle be drawn, the efficiency will be found to be 0.96, while that of the steam portion of the cycle without superheat is 0.384. The combined efficiency is,

therefore, 0.368. Calculations made on a similar basis for a Diesel cycle show that it has an efficiency of 0.554. It is the task, therefore, of the metallurgist and designer to achieve an engine of the external combustion type in which, by means of a regenerative process or otherwise,

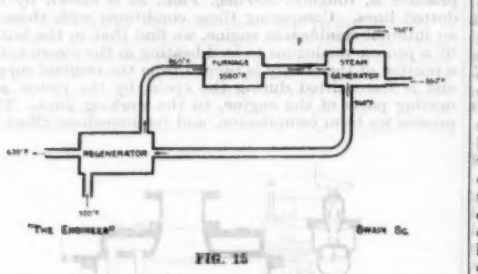


FIG. 15

the wasteful and theoretically unnecessary temperature loss between the furnace temperature and the steam temperature will be completely eliminated, so that the efficiency of the steam cycle may be raised to at least that of the Diesel cycle.

The Ideal Seaport.*

Though the form of transport with which I have been connected all my life is represented by a smaller capital investment than railways or shipping, I venture to claim for it an outstanding position in the industry. A seaport may almost literally be said to have "one foot in sea and one on shore," and, therefore, to belong to both elements upon which transport is ordinarily carried. The navigable streams of this country were utilised for transport long before high roads and railways came into being, and passengers and merchandise were carried to and from ports situated on the streams. Internationally, the seaport is the central point for transhipment and distribution of merchandise.

Seaports are sometimes the creations of their masters—the traders—and have prospered with their masters. Such ports are Liverpool and Middlesbrough. Other ports have been the creators of cities which have risen as commerce in the port has progressed. Such ports are London, New York and Southampton. Alexandria and Immingham, so far as I can trace, are the only ports of any size which have been created by individuals—the one by Alexander the Great and the other by Sir Sam Fay, my immediate predecessor in the chair.

To prevent any misconception, let me say that I am not out to-day to present London to you as the ideal seaport. It may, or may not be, the most commodious, the best managed or the most efficient, and though, in listening to Mr. Szlumper some weeks ago,† we were almost persuaded that Southampton had the supreme claim to pre-eminence, I do not suppose that he more than I would claim his port as ideal—except by comparison. As a matter of fact, the services afforded by one port can seldom be compared with those afforded by another—even a competitive port. It is much easier to compare a railway service or a road service.

What I am aiming at in this address is to set down notes of some important general considerations to be taken into account in the provision of port accommodation, and in the management of the undertakings. Details must be filled in to suit the needs of local traders.

Let us begin with the question of the situation of the ideal seaport—and the first point I make under that head is that seaports do not best fulfil their destiny if they are situated on the coast. It is not proximity to the sea that is wanted, but accessibility to and from the sea, and, subject to certain limitations, the further inland a seaport is, the greater its hinterland and, therefore, the greater its capacity for the distribution of incoming traffic and the reception of cargo outwards. The enormous increase in the size of sea-going vessels during the last 400 or 500 years has left some of the ancient ports stranded. London and Bristol have survived because their waterways were relatively broad and deep right up to their quays, but even Bristol has reluctantly had to accommodate the large steamer traffic nearer to the sea. It is significant that the three great *entrepôt* ports of Europe—London, Hamburg and Antwerp—are all about 60 miles from the open sea, and this is about as far inland as practical considerations governing the ideal to-day will allow a great port to be created.

In dealing with this question of situation, let us not lose sight of the primal fact that all ports exist for sea-going traffic, and that the convenience of the owner of the merchandise and the consumer ultimately fixes the situation of the port. Thus, for coalfields near the sea, such as those of South Wales and Durham the shipping ports are necessarily on the coast. Again, for vessels chiefly devoted to carrying passengers, the ideal port is probably not an inland one. There are the coast ports of Liverpool, Southampton, Dover and Harwich, developing their passenger trades. Liverpool, moreover, had had the benefit for many years of being the nearest port available for the imports and exports connected with the thriving cotton towns of Lancashire, clustered in an area within 40 or 50 miles of the Mersey. The citizens of Manchester built the Manchester Ship Canal and continue to extend its spacious docks and warehouses with a view to bringing the port to their doors and, incidentally, to derive revenue from the facilities offered to other towns. Their success is a demonstration in practice of the truth of the broad doctrine which I have been endeavouring to enunciate.

The question of docks *versus* river quays has long been the subject of controversy on the Thames. River quays are suitable for cargoes in bulk, such as timber, coal and oil, and also for passenger vessels. Docks are more convenient for the discharge of large mixed cargoes such as come to London, and also for the loading of export cargoes.

It will be found that, in British and European ports generally, the preference given to a dock or river system is in every case determined by the tidal range. Thus, in Liverpool, Bristol and Havre, where the variations in tide are extensive, docks are preferred, whilst at Hamburg and Rotterdam, where the range is small, the open river quay system is adopted.

Whatever the form of accommodation, I urge concentration of accommodation in the ideal port. London has long suffered by the dispersal of its docks and public wharves and warehouses over a length of nearly 30 miles of river. This spreading out of the port involves expensive transport of goods between the vessel and their destination, especially by road conveyance—adds thereby to the cost of transhipping and re-exporting of goods, necessitates lengthy journeys for merchants and the staff of everyone concerned—and the cost of supervision in the docks is unduly high. The position in London is only saved by the facilities for water transport.

One benefit to be derived from the concentration is that it makes it possible to introduce the principle of the Customs-freeport into British ports. This principle has long been conceded in German ports. In Hamburg merchants can, within the zone of the free port—the zone includes all the docks—do what they will with their goods, including the conversion of the raw material into manufactures and also their exportation, without the trouble and expense of accounting to the Customs—only having to deal with the Customs and pay duty if the goods are ultimately taken into the interior. The ideal port should be such a free port.

Size of Docks.

One of the most important questions facing those who manage ports is for what sized vessel any new accommodation should be provided. This question was discussed at length at the recent International Navigation Congress. Shipbuilders complain that dock owners are chary of spending money to accommodate ships of 50,000 to 80,000 tons. Dock owners reply that the business is not good enough. Docks for these leviathans are so costly that, even if every berth was always occupied, the tariff rates on the vessels would never yield a fair return on the outlay. Such vessels would invariably be passenger vessels with little cargo. It is the revenue from accommodation required by cargo which is the only financial justification for a new dock. The Southern Railway is meeting the existing situation by providing the necessary facilities at Southampton, including a floating dry dock, whilst the Port of London Authority are about to construct works at Tilbury, which will enable them to bid for, if not secure, this very unlucrative traffic. At the recent conference, Sir Cyril Kirkpatrick stated that he estimated the cost of a dock with twenty berths for mammoth liners would be nearly £14,000,000, and he expressed the opinion that the increased expense due to the great capital cost of very large vessels and the increased dues, will more than outweigh the advantages to be gained in working, and he doubts whether the building of such vessels is really in the best interests of the general public who ultimately have to pay. I cordially endorse that opinion.

The details of the facilities to be provided at a port belong to a region of the subject where the civil and mechanical engineers necessarily speak with greater authority than I can. I will, therefore, touch these lightly. Such things as curvilinear quays are the survival of a past generation and would not be proposed to-day, but I do not think that all engineers realise the importance of continuous straight lines of quay unbroken by angles or by passage-ways into other docks.

There is another point. The width of docks is seldom sufficient. Room is allowed for a vessel on both sides of the dock, but often it is overlooked that there may be craft two or three deep attending vessels on each side of the dock. Then there ought to be a passage-way left for the safe navigation of light vessels in windy weather and other traffic from one end of the dock to another. For ports dealing with moderate sized vessels not less than 350ft. width is desirable and, where the land allows it, an extra 100ft. or 150ft., in the case of large docks, will be found useful and remunerative.

The question of dock cranes is, in itself, large enough for a paper. Even coal cranes and hoists would of themselves repay a sitting devoted to them. Hydraulic *versus* electric seems to have been settled by the acceptance of the hydraulic system where it is already installed and by the introduction of electricity where a new installation is being erected. And I think, too, that the 30-cwt. lift, with 3 tons at a slower rate, is now recognised as the most useful crane for general cargo purposes. Floating cranes for heavy lifts, attending vessels as required, appear to me to be superior to the provision of such cranes on shore. Fixed cranes are never in the right place, and to move vessels to them for special jobs is undesirable economically. These extra powerful cranes—whether floating or fixed—do not pay, but no port could be ideal without them.

The adaptation of the conveyor system to the discharge of ships and for the manipulation of cargo on shore has made immense developments in the last twenty years. I am a firm believer in the possibilities of this class of machine as tending not only to economical handling, but also as preventing damage to packages and their contents.

We are far from the ideal shed for dealing with mixed cargoes landed for the purpose of sorting for delivery simultaneously to rail, road or craft. Soft timber cargoes offer one of the most baffling problems in this respect. One serious attempt I have seen made to tackle this problem of mixed cargoes has been by Mr. Gattie. It was a most elaborate adaptation of his celebrated clearing house for railway traffic most costly to construct and impracticable for working. Port aspirants to fame and fortune might turn their attention to the problem.

Warehousing System.

The storage of goods is an important department at all ports. Everywhere, grain and timber have long been stored. Now we have fuel oils and motor spirit added. At the larger ports the warehousing system is extensive and embraces every class of merchandise. In London it is so extensive that the charges for the handling and storage of goods form the largest item of revenue of the Port Authority. The storage of produce is the oldest industry in the world next to that of agriculture, and it is not surprising, therefore, that little change has taken place for many years in the structural design of warehouse buildings, except so far as the materials now employed in the building offer a greater resistance to fire. Some of the modern warehouses provide for the storage of goods in high piles, but, though this may economise space, few classes of package will stand the weight cast upon the lower tiers; and when particular packages are wanted, extra expense is often incurred in breaking down and re-stowing the pile. Other developments which have taken place have been in the silo system of storing grain and the introduction of machinery for saving heavy labour on the warehouse floor. Most important of all has been the special class of accommodation for refrigerated goods. Any port aiming at being ideal must provide warehouses for chilled and frozen produce and must also fit them with machinery for discharging, sorting, storing and delivering such produce with the minimum amount of handling by the human element—and with no intervening barge or rail transit between the steamer's hold and the warehouse.

The address concluded with observations on the subject of management, rates and charges, staff and labour.

* Abstract of presidential address delivered by Sir Joseph G. Broodbank at the Institute of Transport, on Monday, October 1st, 1923.

† "The Operation of a Railway-owned Port," G. S. Szlumper (member), "Journal," Inst. Transport, Vol. 4, No. 6.

Twin-screw Steamer Sarpedon.

By the courtesy of the directors of the Ocean Steamship Company, we recently had an opportunity of making a trip from London to Glasgow, a distance of nearly 760 miles, on board the twin-screw steamer Sarpedon, after the completion of her maiden trip to China and back. The Sarpedon is the first vessel of a new class of passenger liners built for the Blue Funnel Line for service to the Far East. Her gross tonnage is 11,321, giving her a carrying capacity of 10,950 tons of general cargo and 2550 tons of fruit or refrigerated cargo. Her length is 490ft. 9in. between perpendiculars and her moulded breadth 62ft., her depth being 39ft. Her hull embodies the usual distinctive features of the Blue Funnel liners, including the raked stem with its rounded rolled steel plates above the water line. She has nine water-tight bulkheads extending to the upper deck, horizontal and vertical sliding water-tight doors being fitted in the water-tight bulkheads, operated by hand as well as by the Scott-Ross electrical system. A fire-resisting bulkhead is built between the upper and centre castle decks, and one between the centre castle and boat decks. These are in addition to the usual steam and hand services for securing the safety of the ship against the spread of fire.

The accommodation for the passengers, of which 155 of the first class only are carried, is extremely comfortable and commodious. The accommodation comprises state rooms on the centre castle and promenade decks as follows:—On the promenade deck two cabins *de luxe*, each with two cot beds, eight rooms with two cot beds each, two two-berth rooms and six three-berth rooms; on the centre castle deck there are fifteen single-berth rooms, four two-berth rooms and thirty three-berth rooms. In addition to the usual saloon, music room, smoke room and lounge, and entrance hall, there is a large and appropriately decorated play room for children, as well as special accommodation for native nurses. Another feature of the vessel's equipment is the laundry, which is provided with the most modern appliances operated by electric motors. The galley and pantry are also fitted with the latest appliances and a large emergency generating set operated by an oil engine is provided on the upper deck for use in the event of the steam plants being out of action. All the winches in the passenger spaces are electrically controlled and driven, and are so arranged that they may be used for the raising and lowering of the lifeboats. The navigation lights are electric and are supplied from either of two sources—the dynamos or the batteries for the wireless telegraph system—being automatically interchangeable in the event of failure of either.

The Sarpedon is propelled by twin screws actuated by single reduction geared turbines of the Brown-Curtis impulse type and developing a total combined shaft horse-power of 7500 on ordinary service with steam pressure at 220 lb. per square inch and superheat at 200 deg. Fah. The steam is supplied from three double-ended cylindrical boilers, each 17ft. 1½in. mean diameter by 21ft. 2½in. long with twenty-four furnaces fitted with forced draught on Howden's system and North-Eastern Marine Engineering superheaters. The turbines are connected by means of flexible expansion couplings to pinions arranged to drive common gear wheels of the double helical type on the main shafting. The revolutions of the high-pressure first reduction pinion and the low-pressure first reduction pinion are 2215 per minute, and the propeller shaft makes 133 revolutions per minute when going ahead and 110 revolutions when going astern. The ratio of the gearing is 1 : 17.05. The high-pressure turbines have ten stages ahead and eleven rows of blades and the low-pressure turbines have eight stages ahead and two stages astern, with eight rows of blades ahead and six rows astern. The details of the gearing are as follows:—

	Pinion.	Wheel.
Number of teeth	35	597
Pitch circle diameter, inches	7.435	126.827
Diameter over the teeth, inches	7.806	127.198
Length of face, inches	35	—
Circular pitch, inches	.6674	—
Angle of helix, degrees	29	7.635
Revolutions per minute	2215	130

The Sarpedon is designed for a cruising speed of 15 knots, but on her first trip to China and back she exceeded it by a comfortable margin.

On the run from London to Glasgow, with a strong head wind against her all along the English Channel, she made an average speed of 16.43 knots, her full speed time being 39 hours 45 minutes for a distance of 653 miles, out of the total distance from the Albert Docks to Glasgow of 758 miles. The weather, on the whole, was fine and the

temperature about normal, but a fairly rough sea was encountered around the south-west coast. Notwithstanding this and the fact that the vessel was only carrying some 500 tons of cargo and not much more than half that weight of coal, with no passengers on board, she acquitted herself very favourably. Only in certain parts of the ship was there any perceptible noise to be heard from the gearing, and it was merely a subdued hum, which would no doubt have been even less noticeable had the vessel been fully laden. A vacuum of 27in. to 27½in. was maintained in the condensers throughout the trip, and the highest speed attained was 19 knots for the space of an hour or two with a slightly favourable tide.

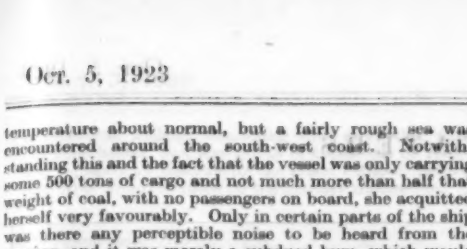
The Sarpedon was built and engined by Cammell, Laird and Co., Limited, Birkenhead. Her sister ship, the Patroclus, is now making her maiden trip to China, and two further ships of the same class are under construction at Greenock and Jarrow. It is intended that these four ships shall maintain a monthly service to the East, making the outward trip to Shanghai in thirty-two days.

A New Dynamo and Battery Regulator.

The problem of controlling the supply of current in connection with the electrical equipment of a motor car is a somewhat complicated one. The dynamo speed is, of course, constantly varying. Moreover, the battery may at one time be fully charged, and at another time fully discharged. An ideal control system would increase the rate of charge when the cells are run down, and the more fully the battery was charged the lower would the charging current become, the supply of current being just sufficient to keep the battery in a perfect condition. Practical considerations call for the elimination of delicate regulating mechanism which requires to be readjusted at more or less frequent intervals.

The usual scheme for making the dynamo charge the battery over the entire range of engine speed involves the use of a dynamo with an auxiliary brush connected to the field, and this gives the desired regulation at varying engine speeds without the use of mechanical arrangements, which are liable to get out of adjustment. When the battery is empty, however, the charging rate is at its lowest value, although it should be at its maximum value, whilst, when the battery is full, the charging rate is at its maximum value when it should be at its lowest value. Thus, if the battery is exhausted, charging takes place slowly instead of quickly, whilst, when the battery is full, current is wasted, the electrolyte is boiled away, and the battery plates are liable to suffer deterioration. Evidently what is needed is a sort of electrical safety valve which will side-track the current when the battery is full, and as the battery becomes exhausted will gradually close until, when the cells are empty, all the current from the dynamo is being passed through the battery and charging is done at a good rate. The device should also protect the system against the effects of accidental breakages or loose connections, which are dangerous, because they have the effect of disconnecting the battery and of sending a current at much too high a voltage through the lamp filaments.

A new regulating system, introduced by the British



NEW BATTERY-CHARGING SYSTEM

Lighting and Ignition Company, Limited, of Greycoat-street, Rochester-row, Westminster, S.W. 1, differs from previous arrangements in that it does not involve the use of mechanical contrivances which call for adjustment. As shown in the accompanying diagram, it consists of an electrolytic regulator which is composed of a number of small sheet steel compartments, containing sheet steel plates immersed in an alkaline solution. The steel plates are connected in positive and negative groups, and the groups of plates in the various compartments are joined in series in the same manner as the plates in a battery.

In a regulator for use in connection with a 12-volt battery there are six compartments, and the weight of the regulator is only a small fraction of the battery which it controls. When current is sent through a regulator of this kind, the water is decomposed, thereby liberating the hydrogen and oxygen. The regulator is connected across the wires which run from the dynamo to the battery in the manner shown in the diagram, and if the pressure of the battery is below 12 volts the regulator does not work, and all the current generated flows into the battery. When the pressure rises above 12 volts, however, the regulator begins to shunt off some of the current and the battery receives less current. When the battery is fully charged only a very small amount of current passes through it, the remainder of the reduced generator current passing through the regulating cells. Thus the current is regulated, so that when the battery is empty it receives its full charge, whilst when it is full it is merely kept in a proper working condition, and is not overcharged. The battery is kept in a good condition, irrespective of whether the car is used entirely for day work, almost entirely for night work, for summer driving, or for winter driving, for long distance touring or for town work. It is claimed, in fact, that the battery is always employed under efficient conditions, and the use of a large dynamo is unnecessary. The only attention which the regulator requires is that involved in occasionally adding a very small quantity of water. Even if the level of the water drops down considerably the regulator continues to operate as long as a reasonable proportion of the surface area of the steel plates is immersed in the solution.

Briefly summarised, the advantages claimed for the regulator are (*a*) the battery is maintained in a more fully charged condition than has been possible in the past, with the result that the average capacity of the cells is considerably increased; (*b*) undercharging and all its attendant inconveniences are eliminated; (*c*) overcharging is prevented; (*d*) the battery needs less frequent inspection and less frequent addition of water to make good the loss arising from evaporation; (*e*) the life of the battery is lengthened; (*f*) more powerful starting is obtained, and all current-consuming devices, including battery ignition, operate in a better manner; (*g*) it is impossible for the lamp filaments to burn out even if the battery is removed from the car.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE EMIGRATION OF WORKMEN.

Sir,—The letter on the above subject which appeared in your issue of September 21st will, no doubt, be greatly appreciated by young readers with communistic ideas and beliefs.

Your correspondent "Ex-Service" appears to think that employers are to blame for the fact that skilled workmen are leaving this country. On the other hand, the undersigned, who has watched the growth of trade unionism since the sixties, and who has long foreseen its dangerous consequences, is of the opinion that "trade unionism" is, in reality, the root cause of the present deplorable state of affairs. The only blame that can be attributed to the employers is the fact that during the war they paid higher wages to the unskilled than they had previously given to the skilled workmen.

Does "Ex-Service" think that any skilled workman worth his salt is going to remain in a country where skill is no longer recognised or appreciated by trade unions, or does he think that any one will indenture his son to a trade which will give him only 57s. a week when he can get as much, or more, working as a scavenger?

Had trade unionism not been in existence, the Clyde engineers would have "played the game" during the war and not have struck work whilst their fellow men were fighting for their lives at the front, and where my three and only sons—Clyde engineers—lost their lives. My youngest son, aged twenty-three, a brilliant pilot, was so disgusted when the strike took place, that he vowed that if he were spared he would never return to the Clyde but would emigrate to Canada.

It was trade unionism that also brought about the railwaymen's strike during the war, and for which the majority of the men were, no doubt, heartily ashamed.

I really wonder if Mr. Lloyd George would have played into the hands of the trade union leaders had he known the powerful lever that he was placing in their hands, a lever that was shamefully used against him at a time when he was doing his utmost to save the country from defeat.

It is due to trade unionism that the British workman of to-day cannot hold his own against the workman of other nations, as he formerly did when it was in its infancy, and when the majority of the men were non-unionists. Had trade unionism not existed the British worker would have been a free man to-day and not the slave he is to a system which binds him hand and foot, and which largely hampers him by removing any incentive to make greater progress.

Thousands of non-unionists have been coerced—by the disgraceful method called peaceful picketting—into joining the unions for no better reason than that they might be allowed to live in peace.

Trade unionism was solely responsible for the recent dockers' strike, thus holding up the country's food supply, incidentally tending to raise the prices of all necessary commodities. The condition of Jarrow emphasises the deplorable harm that trade unionism has wrought; unfortunately, the creeping paralysis now begun may extend throughout the country.

The trade union movement sadly requires a healthy opponent to keep it from ruining the country. What is wanted is a kind of non-union "Mussolini" to appear and form a British legion of free workers, which legion all and sundry could join, including the elements now in the trade union, but which are in them against their will and better judgment. If the trade union leaders once get into power under the guise of a "Labour Government," we may expect in place of the million and a-half of parasites, possibly untold millions of that very unattractive class of individuals.

No, "Ex-Service," the employer has nothing to do with the existing state of affairs. Wipe out that excrescence—the Labour Exchange—form a board of workers who will oppose trade unionism, so that industry may be freed from its paralysing grip; the country will then recover from the deplorable condition into which it has now fallen, and in which it seems, otherwise, likely to remain.

October 1st. Clyde Engineer.

MAIN LINE ELECTRIFICATION.

Sir,—In your references to the paper, which, by the courtesy of President of the Section, I had the honour of delivering to Section G of the British Association, you appear to draw some sweeping deductions which do not appear to be wholly justified; possibly lack of clearness of expression on my part has given rise to these deductions, but the fact that they should have been made is an illustration of the danger of indulging in generalities. From a broad statistical percentage given to illustrate the improbability of general electrification of our main lines, you infer that main line electrification has no future, and that the electric locomotive has nothing to commend it in this country. No observer with an intimate knowledge of both electric traction and railway operation could suggest, without risk of ridicule that the question of a general electrification of main lines is worth a moment's consideration, but you will find in my paper a definite expression of opinion that on certain sections of main line with heavy gradients and comparatively dense traffic electrification would certainly involve no loss and probably be a source of substantial profit to that company which had sufficient foresight, width of vision, and boldness to take such a step. No railway officer, I imagine, would venture to recommend such an enterprise if he thought it would lead to either loss or bankruptcy. It is impossible, however, to ignore the fact that a close relationship exists, and must continue to exist, between the traders of this country and the railway companies, and that their interests in stimulating the export trade on which both live are mutual. It is sound policy to advocate co-operation where it is possible and likely to be mutually profitable; owing to the railway companies' peculiar requirements this is likely to be the case more especially in the engineering trade—a trade, incidentally, whose export business needs more stimulation than any other. Such co-operation in the past has been mutually beneficial in the steel and metal trades, while it is hardly open to argument that electrification in other countries by British firms has been greatly stimulated by the demonstration of electric traction in being on the former North-Eastern, Lancashire and Yorkshire, London, Brighton and South Coast and Underground railways, systems which have been visited by many hundreds of engineers from foreign countries and the Dominions.

I believe I made an erroneous deduction in stating that the net profit per passenger remained constant after a suburban line had been electrified; the statement that the actual cost per electric train-mile was but slightly higher than that per steam train-mile is, however, approximately correct, and is confirmed by the figures given by Sir Philip Dawson in a recent paper before the Institute of Transport. Had the time limit of fifteen minutes for the paper permitted it, the further statements should have been added that the electric train-mile represented a much higher seating capacity and speed than the steam train-mile, and that the increased traffic produced a reduction in the standing charges per passenger on land, permanent way, and stations; this fact is strikingly brought out in a diagram in Sir Philip Dawson's paper illustrating the net receipts per mile of single track for suburban steam and electric traction respectively.

It is unnecessary to trespass at length on your space to refute the innuendoes made in your article in regard to the unreliability of the electric generating station and the magnitude of transmission losses, but it is just worth while to point out that the steam locomotive is not free from failure and is infinitely more liable to failure than the electric locomotive.

You finally appear to suggest the reactionary policy of doing nothing, but wait for some yet unevolved developments of the steam locomotive, or for some internal combustion locomotive of the future; such a policy retards progress by eliminating competition.

You were kind enough to be more than fair to the author and absolutely fair to your subject in the first part of your article, and I trust that the somewhat *ex-parte* conclusions which appear to have crept into the latter part of it may be modified somewhat by the explanatory notes given above, for which I hope you will be able to afford space in your columns.

September 29th. E. O'Brien.

MULTI-CYLINDER LOCOMOTIVES.

Sir,—Your interesting leading article on the above subject has drawn attention to one of the most important developments in British locomotive practice.

Many of your readers will remember that about fifteen years ago I started in the columns of The Engineer what proved to be a most interesting discussion on this subject under the title of "British Locomotive Practice of To-day." I then advocated the employment of three-cylinder or four-cylinder simple superheater locomotives with six-coupled wheels for working the heaviest express traffic. It is interesting to note that these are the most favoured types in service at the present time. The reason for this is not far to seek. Where great power is required, the use of only two cylinders—necessarily of large dimensions—involves enormous piston loads which greatly stress the working parts, resulting in excessive wear and tear. Moreover, these heavy pistons, rods and crossheads are reciprocating masses which can only be partly balanced by means of balance weights in the wheels. This sets up an unbalanced force acting in a vertical direction which, at high speeds, severely punishes the rails and bridges.

Permanent way engineers would welcome the abolition of the two-cylinder engine for fast express work for this reason alone.

The question naturally arises: "Which is the best—the three-cylinder or the four-cylinder engine?" To my mind, the answer to this depends on one's point of view. The four-cylinder is the better balanced engine, but it would cost more to build and probably slightly more to run than would the three-cylinder engine. The three-cylinder engine gives the most even torque and, therefore, makes better use of the adhesion available. The single-throw crank axle also permits the use of larger bearings. All things considered, the three-cylinder-engine would appear to have the best of the argument.

Chas. W. Dauncey.

Birmingham, September 29th.

LAUNCHES AND TRIAL TRIPS.

Sheaf Field, steel screw collier; built by Blyth Shipbuilding and Dry Docks Company, Limited; to the order of the Sheaf Steam Shipping Company, Limited; dimensions, 330ft. 5in. by 42ft. 11in. by 20ft. 9in.; to carry 4030 tons. Engines, triple-expansion, 23½in., 38in., 64in. by 42in. stroke; constructed by the North-Eastern Marine Engineering Company, Limited; launch, September 25th.

Lectures on Ionic and Thermionic Valves.—Professor J. A. Fleming will give a course of six lectures on "Ionic and Thermionic Valves" at University College, London, on Wednesdays, at five, beginning October 24th. The course is open to a limited number. A syllabus of the lectures and particulars as to fees can be obtained on application to the secretary, University College, London, W.C. 1.

Flour Milling Research.—The Secretary of the Department of Scientific and Industrial Research announces that a license, under Sec. 20 of the Companies (Consolidation) Act, 1908, has been issued by the Board of Trade to the Research Association of British Flour Millers which has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The secretary of this Association is Mr. G. H. Ball, LL.B., 40, Trinity-square, E.C.

MULTI-FLOW STEAM SUPERHEATERS.

GALLOWAYS, LIMITED, MANCHESTER, ENGINEERS

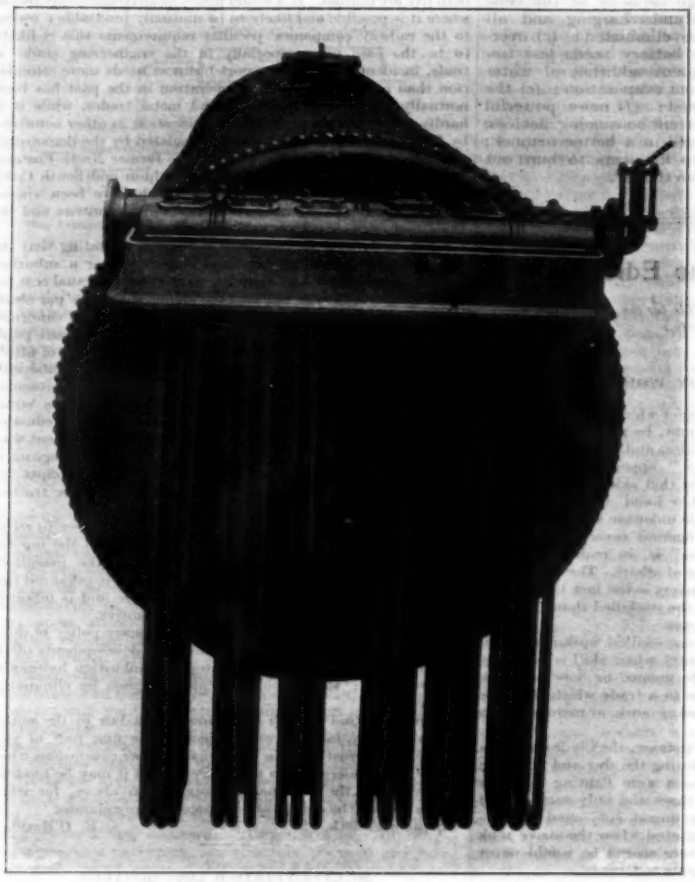


FIG. 1—SUPERHEATER WITH CYLINDRICAL HEADERS

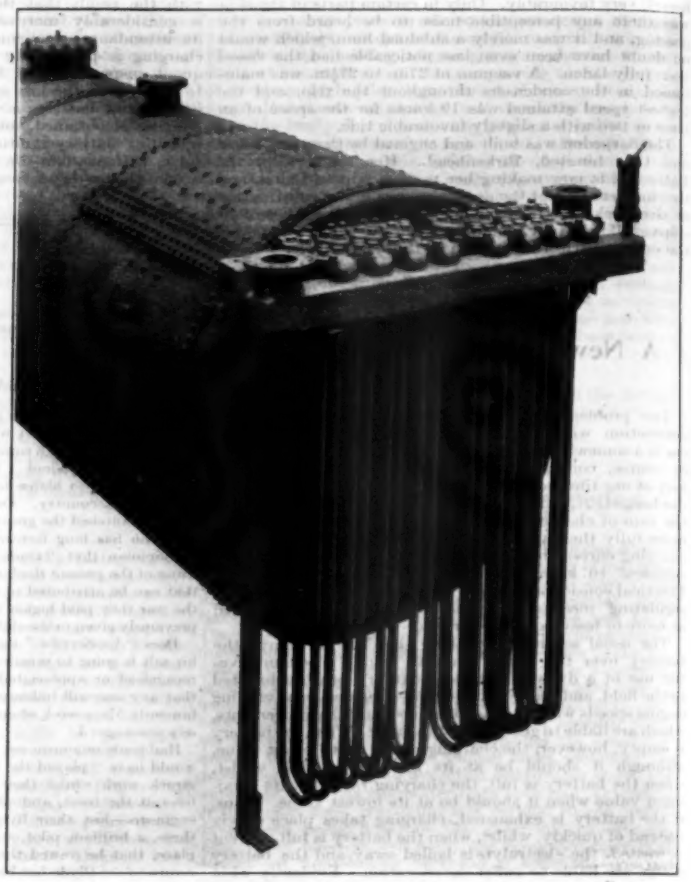


FIG. 2—SUPERHEATER WITH SQUARE-SECTION HEADERS

Multi-flow Steam Superheaters.

THE employment of superheated steam has in recent years become so general that few Lancashire boiler installations are now considered complete without some form of apparatus for raising the temperature of the steam beyond that which is possible in the boilers themselves. Not only does superheating prevent condensation and drop in pressure when the steam has some distance to travel, but the power obtainable from a given boiler may, by the employment of a superheater, be greatly increased. Galloways Limited, Manchester, are making an improved form of double flow superheater, of which we give illustrations in Figs. 1, 3, 4 and 5. It has been specially designed for use in the downtake at the rear of Lancashire and Galloway boilers, where the tubes through which the steam is passing from the boiler to the engine are subjected to the heat of the gases leaving the internal flues of the boiler. The first noteworthy feature of these superheaters is that all their parts are of circular form and are made of wrought steel. Each superheater consists of two horizontal steel headers of circular section connected by a number of weldless steel tubes of U form, $1\frac{1}{16}$in. diameter outside and expanded into the headers. There are no flange joints. The headers are rigidly stayed together—as shown in Fig. 4—with a view to prevent racking stresses due to vibration and expansion. It will be noted in Fig. 3 that one of the headers is divided transversely to form two separate units and the steam passes from the short inlet header by way of the first group of tubes into the long header. From the latter the steam passes through the second group of tubes into the short outlet header. In this way the steam makes a double pass through the tubes.

To prevent damage to the superheater, as well as loss of heat by radiation, the headers are covered by a double-walled cast iron box with a cover. One advantage claimed for this type of superheater is the ease with which it can be removed if required. By means of a sling and overhead crane the whole may be lifted out, and for temporary purposes a length of steam piping can be inserted between the flanges on the inlet and outlet steam pipes. By removing the cast iron cover and the hand-hole doors in the headers access to the tubes is available. To replace a tube the superheater is lifted out and the defective tube cut away, a new tube is inserted, and the ends are expanded in—as shown in Fig. 5. The hand-hole doors are fitted with an internal cover which, while making a very efficient steam joint, is also easy to remove. This superheater is made in several sizes up to a heating surface of 315 square feet obtained by the use of thirty-six tubes.

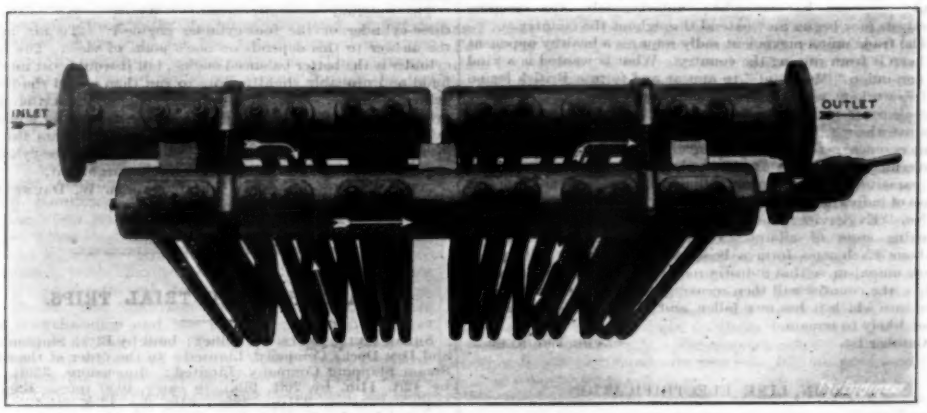


FIG. 3—PLAN VIEW OF SUPERHEATER SHOWING DIVIDED HEADER

An alternative form of superheater made by Galloway, Limited, is shown in Figs. 2 and 6. It is for use in conditions similar to that above described, but the two main steam headers consist of boxes of square section running parallel with each other. The superheater tubes are of U-shape, and are vertically arranged within the recess at the rear end of the furnace and between the two headers in groups of three, but the upper ends of the tubes are expanded into the lower walls of hollow connectors which project inwardly towards each other beyond the opposing walls of the steam headers. These connectors are detachably secured to the upper walls of the headers by means of studs engaging lugs on the hollow connectors and screwed into the upper walls of the headers, the interior of the hollow connectors communicating with the interior of the headers and forming off-set chambers. By this method of construction communication is established between the upper ends of the superheated tubes and the upper sides of the headers without bending over

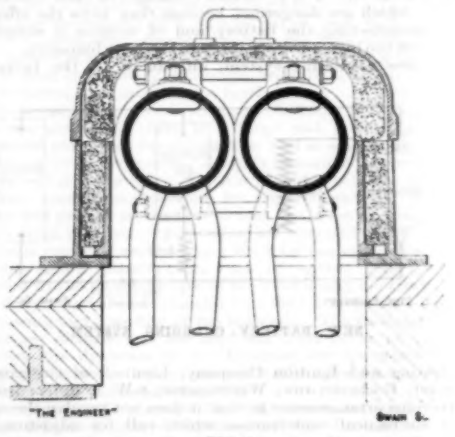


FIG. 4

the ends of the tubes. The upper surfaces of the connectors are provided with screw plugs in order to give

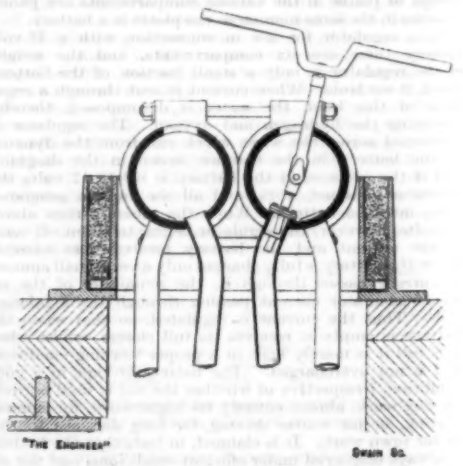


FIG. 5

access to the tube ends for tightening purposes. By this method of construction, either end of any individual tube

is accessible without interfering with any other part of the superheater, and any group of tubes can be removed and replaced by unscrewing the studs without disturbing any other group of tubes or the headers themselves. The

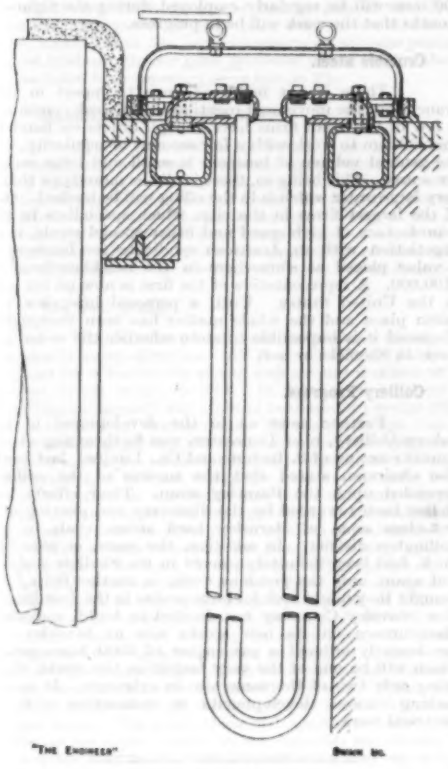


FIG. 6

headers and connectors are enclosed in a suitable cover, which can be readily removed by means of a sling and eyebolts, as shown in the drawing.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Still Hopeful.

Producers of iron and steel in the Midlands and Staffordshire, though the development of demand is generally still disappointing, have not lost faith in the autumn revival, and the somewhat more hopeful sentiment noted last week is still in evidence. Inquiries continue on a better scale and a few more orders are coming to hand. Several Staffordshire mills have booked fairly good contracts, and are resuming work after rather lengthy periods of idleness. There is just a little more activity in structural steel, inspired no doubt by the expectation of a settlement of the boilermakers' dispute. As to the requirements arising out of the calamities in Japan, the only perceptible effect in this district is in the sheet mills. An evidence of the strength underlying the market is the maintenance of values. Generally speaking, a better tone prevails on the Birmingham market, and producers and buyers alike are inclined to discuss the situation in a more optimistic vein than they were a few weeks ago. The number of pessimists is diminishing.

Pig Iron Values.

The slightly improved business in the raw iron department, of which I spoke last week, has this week been added to by a few orders from engineering firms for foundry iron. Smelters have been encouraged in their efforts to stop the decline in pig iron values. On the Birmingham market to-day—Thursday—smelters were not in a yielding mood, despite the fact that they are now able to obtain coke at a reduction of 2s. per ton. They maintain that this has already been discounted. Consumers press for price concessions and express their willingness to take their chance of a tightening up of the market later on if they cannot get concessions. Consequently only a small amount of business is being done. Most of the forges are only partially employed in spite of the fact that rather better orders have lately been booked. Purchases, however, are only made to cover immediate requirements. Foundries producing light castings are fairly busy, but the demand from engineering works, with few exceptions, drags. For forge iron Northamptonshire firms quote £4 1s. to £4 2s. 6d. at furnaces, while Derbyshire smelters ask £4 3s. to £4 4s. Derbyshire No. 3 foundry is sold down to about £4 10s., though the recognised quotation is £4 12s. 6d. Northamptonshire makes command £4 10s. to £4 11s., and North Staffordshire £4 12s. 6d. to £5.

Blast-furnace Coke Reduced.

As the result of a conference between representatives of the Midland blast-furnaces and the coke suppliers a reduction of 2s. per ton in the price of blast-furnace coke has been agreed upon. The new price is 24s. per ton at ovens. The area covered by the arrangement comprises the Lancashire, Yorkshire, Derbyshire, Nottinghamshire, and Staffordshire cokeries. Smelters in this district regard this as a provisional arrangement. They say the concession has been discounted already, and that it will not suffice to meet the situation. The position taken by the coke suppliers is that they are still able to sell their output abroad at prices substantially higher than those they are charging to the home consumer. What effect the new developments in the Ruhr may have on the export demand remains to be seen. Smelters realise that cheaper coke would not of itself remove the present stagnation in the industry; but they maintain that lower production costs must be an essential factor in any real reconstitution.

Finished Iron.

Though inquiries for finished iron are more numerous, actual business does not show much expansion. The re-rolling of steel, partly to meet the requirements of builders of rolling stock, is at present the stand-by of the district. There is a good deal of speculation as to what may be the outcome of the alteration of the Ruhr position. Marked bars continue their favourable position, enabling makers to retain the comparatively high figure of £14 10s. Crown bars are irregular in price. While £12 is the usual quotation and business is being done at less, some makers state that they are getting £12 10s., which is the price still quoted by North Staffordshire houses. Makers of merchant bars complain of the unremunerative character of business, and one Staffordshire firm is stated to be closing down as it cannot make bars at the prices ruling to-day. It is reported that Birmingham merchants are selling merchant iron at £11 7s. 6d. and £11 10s. Staffordshire bars at £12 cannot be sold under these conditions. Only a restricted business is passing in nut and bolt bars at £10 15s., makers having no chance against the Belgian quotation of £8 12s. 6d. delivered. Iron strip commands £12 10s., but some mills refuse to sell at less than £12 12s. 6d.

Galvanised Sheets.

Many of the sheet iron mills are booked into next year and are refusing further business for 30-gauge sheets. There is not the same stringency in regard to 24-gauge galvanised corrugateds, however. The generally recognised price for these sheets is £19 f.o.b. This does not satisfy the more favourably placed producers, who demand £19 5s. On the other hand, it is reported that in one case at least supplies are being offered at £18 15s. Some of the black sheet mills in South Staffordshire are now making full time. Values are firm at about £14.

Ironworkers' Wages.

Ironworkers' wages, contrary to expectations, are to remain unaltered during the next two months. When in August a 7½ per cent. increase was announced it was considered that the decline in values of bar iron would result at the next review in wages coming down again. Marked bars have, however, for many months now remained stationary at £14 10s. per ton, and this fact in great measure is responsible for the result of the last ascertainment of wages, which are regulated by the sliding scale under the Midland Iron and Steel Wages Board, and which shows "no change." The plusage over the base rate of 13s. 6d. now stands at 57½ per cent.

Steel.

The steel position has improved somewhat, especially for semi-finished material. The price has not materially changed, £7 15s. being accepted for ordinary mild steel billets. But fewer mills quote this figure, £8 and upwards being much more common. French billet makers continue to show more interest in the market. They quote something less than £7 15s., but the difference will have to be greater before there is any material diversion of business. The somewhat more hopeful outlook with regard to the boilermakers' dispute has had a favourable influence, as any resumption of work would stimulate activity at the shipbuilding yards, and a number of contracts calling for steel for building and repairs could at once be undertaken. There is no change in the value of angles and joists, which remain at £9 10s., or in tees at £10 10s. Demand for plates is sluggish. Though most of the big makers of ship, bridge and tank plates ask £10 5s., it is possible to place orders at £10. Boiler plates remain at £13 10s. Steel hoops of Staffordshire make are quoted £12 at works.

Scrap Prices Advance.

Scrap buying has been resumed, and this week some fairly good sales have been made of steel scrap at about £4 2s. 6d. per ton, which is an advance of fully 5s. per ton on recent prices. Holders are now disposed to retain their material pending the higher prices which, they maintain, must come along in the near future.

Heavy Edge Tools.

The heavy edge tool industry in the Midlands, which has been extremely quiet of late, shows signs of brightening. Inquiries are stated to be much more numerous and likely to bear fruit in the shape of orders. The renewed activity in business is not confined to any particular market. India is buying well and Brazil shows signs of opening up again and offering good prospects.

Midland Workless.

The unemployment returns for the Midlands continue to show a decrease in the number of persons out of work, the figures having fallen from 169,639 to 168,430. The aggregate is made up of 121,785 men, 4633 boys, 36,127 women, and 5885 girls. The number of workless in the Birmingham area is now 41,730, in Bilston 3935, Coventry 6066, Cradley Heath 5068, Dudley 4258, Smethwick 5399, Stourbridge and Brierley Hill 3364, Walsall 6345, West Bromwich 3806, and Wolverhampton 8448.

Obituary.

I regret to have to record the passing away, at his home in Wolverhampton, on Tuesday, of Mr. W. H. Bostock, a partner in the well-known South Staffordshire iron and steel making firm of Tolley, Son and Bostock, Green Forge, Darlaston. Mr. Bostock was in his sixty-third year and was well known and highly respected in Midland iron and steel circles. He was a familiar figure on the Birmingham Iron and Steel Exchange.

LANCASHIRE.

(From our own Correspondents.)

Manchester, Thursday.

General Outlook.

The markets for iron and metals in Manchester are still waiting more or less patiently to feel the effects of the improvement which is reported from other districts, and as they wait a certain scepticism as to the *bonâ fides* of these reports is growing. A week or two must pass no doubt before anyone can be sure of the effect on the markets, first, of Japanese reconstruction, and secondly, of the return to work—if it takes place—in the Ruhr district. Apparently there is a prospect of a release of large quantities of pig iron and of scrap, which may influence the continental markets for a time; but this cannot be of any permanent importance. What is of the first importance is whether or not it will be possible to get the coke ovens quickly into order, for this would tell on the supplies of coke and might have the effect of bringing down the prices of furnace coke in Great Britain.

Metals.

The markets for the non-ferrous metals have been rather irregular here, but so far as can be seen the volume of business has not increased. The demand for refined ingot copper is only moderate, and this is attributed to general slackness amongst the engineers. Low prices do not tempt them to buy, and when there is a little spurt, as was the case a few days ago, buyers are not frightened. They assume that there can be no serious rise in prices, and that small speculative fluctuations can be safely ignored. This view has certainly been justified for a long time, for there has been a fairly steady fall in refined copper since last May, and every little attempt on the part of American interests to support the market has failed. At the end of September refined copper was quoted at exactly the same price as at the end of August, the fluctuations in the meantime having been confined within £2 per ton, or, say, about 3 per cent. The position in copper might, of course, be greatly improved if a settlement between France and Germany would allow of a return to normal working conditions in the latter country. German copper consumption is required by the American producers if prices are to be sustained without a drastic reduction in the output. There has been practically no change in the market for old metals. Dealers have repeated their buying prices for some months without serious alteration. For clean scrap copper rather less is being given by them here, but for scrap gun-metal and yellow brass the buying prices remain at £46 and £37 per ton respectively. The manufacturing engineer can have these metals cheaply; but the mere fact that he is disinclined to buy shows the state of trade. Tin is thought to be a fairly sound market at present levels. The supplies and the consumption are fairly well balanced just now. The only doubt is as to the attitude of America, which has not yet come into the market to any great extent. If she begins to buy, prices may recover again to well above £200, but if not, it is doubted by some experts whether the demand will be sufficient to keep the prices steady. Lead has been quite a strong market of late, and the price of foreign lead has improved during the last month by £1 per ton. Supplies have been liberal of late, but perhaps the expectation of a demand from Japan is keeping the market up. Spelter has been an easier market lately, apparently in the expectation that supplies from Germany may soon be resumed.

Pig Iron.

The markets here for foundry iron are in a state of suspense at the moment, and opinions as to the future differ very widely. The point is whether the return of the workmen in the German fuel industry will actually have much effect on furnace coke prices here. There has been certainly some ease in Durham, and fuel there is easier; but the nominal price in the Midlands is still 26s. per ton and in Lancashire 30s., and until the Midland price is lower one cannot see how the price of foundry iron here is to come down, at any rate below about 97s. 6d. per ton delivered. To-day the nominal quotations for Derbyshire No. 3 pig iron range from 90s. to 92s. 6d. on trucks; but, as a matter of fact, most of the small business being done here is at 91s. Some sellers say that there has been forward buying at this price, and take this as an indication that buyers no longer hope for any substantial fall; but one has the idea that only a very little forward buying has taken place. Most consumers are waiting to see what will happen. The total consumption of foundry iron in this district is no better than it was, or has been, during the last three months. There is little doubt that the general tendency of prices is downward, and is only checked by the cost of production. Cleveland iron is not now selling as freely as it was, and any further fall—which would almost certainly come if northern coke were cheaper—would take some business away from the Derbyshire furnaces.

Steel.

The position in steel is rather different from that in pig iron, because there is practically no margin for a further fall even if fuel becomes cheaper. The outlook seems now to depend upon whether the boilermakers' dispute is settled, and orders which have accumulated will be released for plates and angles. The nominal prices here are about £9 5s. to £9 7s. 6d. for angles and £9 15s. to £10 for plates, but the tone of the market seems rather better than it was. This may be a reflection of the firmer feeling in the North-East. The demand for finished iron here remains poor, but, of course, the prices, in relation to those for steel, are high.

Scrap.

One cannot say that there is any change in the dull and lifeless condition of the markets for scrap iron and steel. Cast scrap, of course, reflects the position in the ironfoundries and confirms the belief that most of these foundries are short of work. The prices quoted by the dealers here still range from 80s. to 85s. per ton delivered, the latter being for choice qualities. The prices are low enough and would attract more custom if the foundry trade were in a better condition. Heavy melting steel scrap at a Lancashire station is worth about 62s. 6d. per ton. For heavy wrought scrap the ironworks of Lancashire are paying from 75s. to 80s. delivered, and appear to be getting as much as they want at these prices. Dealers say that the trade in wrought scrap does not pay them.

Manchester Association of Engineers.

On Thursday, 27th ult., more than one hundred members of the Manchester Association of Engineers, accompanied by their president, Mr. Cecil Bentham, paid a visit of inspection to the Penistone works of Cammell Laird and Co., Limited, which were recently described very fully in these pages. The original works, with an area of 22 acres, were purchased by Charles Cammell and Co., Limited, in May, 1864, having been built some few years previously. From 1864 until 1917 they were employed exclusively in the production of acid Bessemer steel, which was manufactured into ingots, rails, structural sections, fish-plates, railway axles and tires, &c. Since 1917 the works have been largely remodelled and extended and now cover a total area of approximately 60 acres. The 34in. rolling mill, equipped with a 19,000 horse-power electric drive and all the most modern handling devices, is justly claimed to be one of the most efficient in the country. Six 60-ton open-hearth furnaces of recent construction maintain an adequate supply of steel for rails, billets and blooms. The works also contain a 14in. mill devoted principally to the rolling of the lighter section of rails and fish-plates, spring steel, steel bars, &c. There is also a Bessemer plant containing two converters of 12 tons capacity. In 1919 the company decided to consolidate its three railway tire producing plants. With this object in view, buildings were erected at Penistone and equipped with a highly efficient plant for this class of work. Throughout the works electrical driving is employed wherever practicable, current at 10,000 volts pressure being supplied by the Yorkshire Power Company and transformed down to the required voltage on the premises. After inspecting the works the members were entertained to tea by the company.

Barrow-in-Furness, Thursday.

Hematite.

There is no alteration in the condition of the hematite pig iron trade, which remains dull. There is just a sort of feeling in the market that a slight improvement is likely to take place in the early future, and this opinion is probably influenced by the number of inquiries coming to hand. No doubt the next two months will see better business being done. Present orders are only for immediate requirements and, generally speaking, the output is low, this condition being influenced by the fact that the local steel works are not taking any great quantity. Neither the home nor the overseas market is bright at present, but there are signs of better things. With the steel works, particularly the rail and merchant mills, quiet at Barrow more pig iron is available for sale, but some is going into stock. The charcoal furnace at Backbarrow is engaged and there is a steady trade for this special class of iron. The Scotch and South Wales trade is dull as yet, but small cargoes are going to North Wales.

Iron Ore.

The iron ore trade is very quiet indeed and no mines are fully engaged. This condition will continue until there is an improvement in the local iron trade. Some mines are idle. The business done in foreign ore is not heavy by any means and stocks still exist at the docks.

Steel.

The Workington Mills, which have a pretty big order for the Gold Coast, will not complete the order right off, but will work on it at intervals between now and the end of the year. The Barrow rail and merchant mills are idle this week, but there is some talk of their re-starting next Monday. The foundries are engaged and there is plenty of work for the hoop mills. The section mills are also kept active.

Shipbuilding and Engineering.

There is a slight improvement in the shipbuilding and engineering departments at Barrow, and, given a settlement of the boilermakers' dispute, of which everyone is utterly sick, there will be a great improvement in the former. The orders issued by the Admiralty under the scheme for providing work for the unemployed have resulted in work being given out, and there has been an increase in the number of employees in the departments affected by this work of overhauling and refitting.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

There is no improvement to report in the condition of the heavy branches of the steel trade, but rather the reverse. Some authorities consider that the past week has been the worst of the present year. It has been characterised by a falling-off of orders in all departments. There are many inquiries, but here, too, a decline is noticed, and a large proportion of those which come through fail to materialise into actual business. An exception to the general decline is provided by the shipments of steel to the East, but these are comparatively few. There are still optimists, who point out that the end of the quarter is always a lean time for buying, and that the third quarter of the year is the worst of all. They consider that some revival of interest in iron and steel may be expected at any time now. The effects of the new developments on the Ruhr have not yet shown themselves, and it is difficult to predict what they will be. The reports one sees as to the large quantities of steel in the Ruhr, already manufactured and ready to be sold, are hardly cheering.

Railway Work.

Work in this department keeps up pretty well, though it is not sufficient to employ the whole of the city's extensive productive capacity. Orders are now on hand for axles, tires, springs, and other equipment for South Africa, Egypt, India, and South America. Hopes are still entertained of the receipt of a large volume of work from the home railway companies before long. There are those who take a favourable outlook for the future, based, not only on railway requirements, but on the need of steel constructional work generally. There is no doubt a great shortage of iron and steel material in all parts of the world. Many schemes of construction or renewal are long overdue, having been held up until the times became propitious for releasing them. When they are proceeded with they will be sure to have a beneficial effect on the trade position.

A Steel Company's Report.

The principal official announcement with regard to trade published this week is the annual report of the United Steel Companies, Limited, one of the largest amalgamations in the country, which has steel works and collieries in the Sheffield district, ironworks in Lincolnshire, more steel works in Cumberland, and many other branches. The concern has done very much better than it did in the preceding twelve months. "The trade depression referred to a year ago," say the directors, "continued with rather less intensity until very close up to the end of 1922, when a material improvement was experienced, and the works which had been idle were enabled to resume operations to a moderate extent. The improvement is not quite so pronounced at this date, but considerable business is in hand, and there are large inquiries." The trading of the company's branches and subsidiary companies for the year ended June 30th last resulted in a total net profit, before providing for depreciation, income tax and corporation profits tax, of £605,506, as compared with a loss on the same basis for the year ending June 30th, 1922, of £505,531, an improvement as compared with the previous year of £1,111,037. The net surplus at June 30th, 1923, was £666,149, as compared with £440,743 the previous year. Having regard to the requirements of increased business, the directors consider it advisable to conserve the resources of the company, and they therefore do not recommend any distribution in respect of dividends. The directors also report that during the year the company acquired an interest in the Hoffman Manufacturing Company, Limited.

Cutlery and Plate.

There is an improvement in several sections of the cutlery trade, although on the whole it cannot be called great. Sheffield continues to turn out large quantities of table knives, particularly of the stainless variety. Firms who make hafting material report heavy sales of handles for this purpose, and there is also a better inquiry for ivory handles and scales. Buying for the Christmas season is having a beneficial effect on the trade. There is also an increase in the demand for pen and pocket knives, which is attributed to the cessation of German imports. The trade in razor blades continues poor, except in a few cases, but the failure of Germany to keep up her supplies is expected to prove helpful before long. The plate factories are feeling the benefit of the Christmas demand, but there is not much activity in the hollow-ware departments. The makers of cases to hold articles of cutlery and plate are busy. The call for large cabinets and canteens, however, while of a steady character, represents only a small proportion of the work on hand. Small and low-priced goods are mainly in demand, and every week Sheffield produces thousands of cases containing spoons and forks, table and tea knives, fish eaters and similar articles. Prices are so keenly cut, however, that much of the business produces little or no profit.

A New Industry.

A new works recently established in Sheffield is that of the Anglo-Galvanising Company, Limited, for the purpose of working patents in a new and improved system of galvanising sheet metals. The process embodies the use of a solution which is said to make good the zinc deposited on the work entirely from the anodes, dispensing with the necessity of restoring it from time to time by the addition of chemicals. Another advantage claimed for the system is the great saving of time occupied by the operation, and of expense, while it gives a much better product as regards both finish and durability. As the process is a cold one, there is no danger of the articles being distorted by the heat of the solution. The cost of installing the system is stated to be low, and it is easily adapted to existing systems. The patent is being worked in America and other countries.

Sheffield's Telephone Exchange.

A start has now been made with the building of the superstructure of the new automatic telephone exchange for Sheffield, which, when completed, will form an imposing addition to the business premises in the centre of the city. Occupying an island site of about 16,000 square feet, or two-fifths of an acre, it has a frontage of 192ft. to Bow-street, 160ft. to Pinfold-street, and 120ft. to Holly-street. The framework is of steel and the superstructure of Portland stone, of which 40,000 cubic feet will be used. The building rises to a height of 80ft. and consists of a basement and four floors. The floors are to be of reinforced concrete, in which about 40 tons of reinforcing rods will be used. Besides containing accommodation for the various departments of the telephone service, the building will include a number of shops and offices for letting purposes, and at one corner will be a post office. The contract for the superstructure, which is being carried out by Henry Boot and Sons, Limited, amounts to £73,000. Of this sum, £38,000 will be spent in wages, and about 200 men will be regularly employed during the eighteen months that the work will be in progress.

Crucible Steel.

There is not much advance to report in this branch, but the movement mentioned last week continues. A few of the small firms have enough orders on hand to enable them to work with a fair amount of regularity, but the general volume of business is small and large orders are scarce. This being so, there is all the more hope that a very large order which is in the offing will be booked. One of the largest firms in the city, which specialises in the manufacture of high-speed and other special steels, is in negotiation with an American syndicate for business of a value placed at somewhere in the neighbourhood of £100,000. A representative of the firm is now on his way to the United States. Until a personal interview has taken place and the whole matter has been thoroughly discussed it is impossible to state whether the order will come to Sheffield or not.

Colliery Progress.

Further news as to the development of the Askern Colliery, near Doncaster, was forthcoming at the annual meeting of S. Instone and Co., Limited, last week. The chairman stated that the success of the colliery depended upon the Barnsley seam. Their efforts had at last been rewarded by the discovery and proving of a first-class seam of Barnsley hard steam coals in the Pollington district. In addition, the seam, of over 8ft. thick, had been definitely proved in the Skellow district, and again, only the previous week, in another drift. He thought they might look for large profits in the near future. The Staveley Company has decided to build a modern blast-furnace on its new works site at Staveley. It has recently ordered a gas engine of 8000 horse-power, which will be one of the very largest in the world, there being only two of the same size in existence. It is also making various developments in connection with its electrical work.

NORTH OF ENGLAND.

(From our own Correspondent.)

Biggest Steel Exports for Nine Years.

Although considerable leeway has yet to be made up before anything like a normal state of industry is reached, the present position in the North of England is full of promise, and the outlook distinctly brighter. A most hopeful factor is an expansion in the exports of manufactured iron and steel, and the encouraging fact emerges from the September returns that the shipments during that month were the highest recorded since May, 1914. It would, of course, be unwise to deduce therefrom that the iron and steel trade has turned the corner, but at the same time it provides an indication that business is on the upward trend. Altogether, the manufactured iron and steel exports for September aggregated 63,843 tons, which, though only 1420 tons better than the March total, exceeded the August figures by over 50 per cent. The shipments to India, amounting to 20,089 tons, were the heaviest of the year, and there were also heavy loadings for Egypt and Nigeria. Curiously, rather a less quantity of manufactured iron and steel was shipped to Japan, but, of course, reconstruction orders have only as yet started to dribble in, and when the real work of rebuilding has been started, big business is looked for. The pig iron shipments were almost identical in volume with the August exports, totalling 34,827 tons, compared with 34,795 tons. Business with Germany fell away from 15,247 tons in August to 4833 tons in September, but recent sales promise some recovery in the current month. To Italy precisely the same quantity was shipped as in August, but it is many years since Cleveland despatched as much as 5272 tons of pig iron to Norway and Sweden in one month, whilst better business was also done with the United States, with Scotland, and also with the free port of Danzig.

Cleveland Iron Trade.

The position in the Cleveland pig iron trade shows a slight improvement on the week. A good many more inquiries are circulating, but they are chiefly confined to the export department. There is as yet no evidence of any real revival of the home demand, consumers being slow in coming forward to cover their autumn requirements. In some respects, however, the ironmasters are finding the situation more favourable. During the past week or two furnace coke has not only become more plentiful, but also much cheaper. This, of course, spells a considerable measure of relief in the costs of production, which will be further reduced in the course of the next few days when the new ascertainment for the third quarter of the year will undoubtedly involve a sliding-scale cut in blast-furnacemen's wages. Of course, these economies in costs have been anticipated by the ironmasters in their quotations to consumers, but still they will ease the situation and may even result in further price cuts, although the prevailing opinion is that the market has just about touched rock-bottom. Some makers still quote 96s. 6d. for No. 3 G.M.B. Cleveland pig iron, but it is understood that business has been put through at 96s. No. 1, which is still as scarce as ever, commands 102s. 6d., whilst No. 4 foundry is 91s., and No. 4 forge 89s.

Hematite Pig Iron.

The improvement in the East Coast hematite pig iron trade is well maintained. There is no rush of buyers, but still a fair amount of business continues to be placed, both on home and export account. Prices vary from 98s. 6d to 99s. for mixed numbers, and up to 100s. per ton for No. 1.

Iron-making Materials.

Quietness still characterises the foreign ore trade. There is little demand for Mediterranean ores owing to the glut at most of the works, and there is very little activity in Spanish ores, although one or two cargoes of best Rubio ore are understood to have been sold at about 23s. per ton, c.i.f. About 38s. now represents an average price for good medium furnace coke delivered at the works, though sales have been reported at as low as 35s.

Manufactured Iron and Steel.

There is a distinctly better tone in the manufactured iron and steel trade consequent upon the placing of a number of orders in this district, chiefly for railway material and light sections. Until the shipyard dispute is settled, however, there can be no real activity at the steel works on the North-East Coast, where so much of the plant is usually engaged on the production of material for the shipbuilders. Quotations all round are unchanged.

The Coal Trade.

The Northern coal trade maintains a steady tone in nearly every direction. All the collieries are fairly well placed for a few weeks ahead, and are not inclined to discount prices to any extent. In fact, most of them are holding out against any attempt to discount current prices, even for forward transactions. Merchants are not disposed to concede anything like present prices for next year's delivery as yet; so that what business is put through is for prompt, or at least within the next two or three weeks. The situation in the Ruhr and the conditions for trade with Germany generally are still coming in for considerable discussion, but the diversity of opinion is so marked, and the information so meagre, that none of the large operators are prepared to back their opinion They prefer to hold back and await events. So far, there is no news of any cancelments of contracts or postponement of shipment, though these contingencies are to be reckoned with, and are the occasion of concern in more than one quarter. There is, however, a disposition on the part of the German authorities to scrutinise closely each individual transaction before an import licence is granted. The effect of this will be to hold up some of the shipments for at least a little time in some cases. There is nothing of importance under discussion for the export trade. A few inquiries are coming forward, but they are not pressing even when they are in circulation. The trade with France and Italy is quiet, and so far no very great development in business with either country is looked for. The hope for permanent expansion of trade lies rather in the home industrial demand, and if that begins to expand to any extent, the forward coal market position will be much more stable and assured. The Northumberland steam coal trade is rather quieter than it was, but values display no material alteration, with the exception of small steams, which are easier. There is a fair market at the moment for gas and coking coals. All the best qualities are a shade firmer, with secondary sorts also inclined to stiffen. The coke market is steady throughout. All foundry classes are in good demand and are firm, while gas coke of every make is also in good demand.

New Blast-furnace to be Started.

A new blast-furnace, having a capacity of 2000 to 2500 tons per week, is shortly to be put into blast at Messrs. Dorman, Long and Co.'s Port Clarence Ironworks. The furnace is replete with all the latest appliances. It is 80ft. high, while the bosh is 21ft. 6in. in diameter, and the hearth 13ft. in diameter. It is equipped with the Wrightson Kinquist automatic charger, and all the apparatus for handling the materials, including the coke and the ores, is electrically driven. The furnace will be blown by a turbo-blower. It is to be put into blast in substitution for another already in use, so that the number of furnaces will not be increased.

SCOTLAND.

(From our own Correspondent.)

Outlook More Hopeful.

A BETTER feeling exists in industrial circles, probably as a result of the latest efforts to effect a settlement of the shipyard dispute. Consumers have been sounding markets with a view to future requirements, and prospects of business on more settled conditions are improving.

Shipbuilding: Continued Low Output.

The output of tonnage from Scottish shipyards during the month of September, though better than in the preceding month, was a very insignificant figure in comparison with normal returns. The total launchings only amounted to sixteen vessels of 11,289 tons aggregate. Of that total, Clyde yards were responsible for thirteen vessels of 6946 tons aggregate. The largest vessels launched during September were:—The Leikanger, cargo steamer, 3800 tons, built at Port-Glasgow for Norwegian owners; the Norseman, t.s. cable steamer, 1850 tons, built at Clydebank for the Western Telegraph Company, Limited, London; the Porthcawl, cargo steamer, 2773 tons, built at Burntisland for the Porthcawl Steamship Company, Limited, Cardiff; and the Royal Fusilier, passenger and cargo steamer, 1500 tons, built at Dundee for the London and Edinburgh Shipbuilding Company. For the first nine months of this year the total output from the Clyde amounted to eighty-five vessels of 155,222 tons aggregate, compared with one hundred and one vessels of 289,218 tons in the same period last year. The only fresh contract of importance placed during September was one for two liners, each of 15,000 tons deadweight and 11,000 indicated horse-power, to be built by Barclay, Curle and Co., Whiteinch, for the P. and O. Steam Navigation Company. On the east coast of Scotland one or two orders for smaller craft were placed.

Pig Iron: Demand Below Output.

The pig iron market continues more or less in a state of comparative inactivity. The demand for hematite and foundry is confined to immediate requirements, and with these at a low ebb the output is more than sufficient. Makers' stocks are accumulating, and while forward inquiries may be more hopeful actual business is not increasing meantime. Prices are practically unchanged at the time of writing.

Better Inquiry for Steel and Iron.

The steel and iron markets are a shade more cheerful as a consequence of a wider circulation of inquiries, which, it is hoped, may mean more general activity. Consumers are still inclined to continue a policy of delay in the placing of orders, but there are said to be signs of a weakening of this attitude. At the present time steel works are not booking much business in plates or sectional material, and plants are rather poorly employed. The export demand for sheets of the lighter gauges is fairly well maintained, but heavier gauges are still showing little activity. No immediate improvement is expected in the bar iron trade. Home requirements are few, and while export may be better, the prices offered are not very acceptable. The same remark applies to re-rolled steel bars. Generally speaking, practically nothing has been heard here of the business circulating on Japanese account.

Coal Trade More Active.

More activity has been noticeable in the Scotch coal trade generally during the past week. In Lanarkshire the export demand for ells has been maintained, and splints and steams have been a little more prominent than of late. Ayrshire collieries are comparatively well booked for all descriptions of fuel. A steady turnover is reported from the Lothians, and in Fifeshire third-class steams have struck a busy patch, although first qualities are not too well off for orders at present. In all districts washed fuels are steadily moving off, and prices are firm, especially for treble nuts from Fifeshire. The home demand for coal is larger in the household department, but little improvement is noticeable in industrial sorts.

Heavy Coal Shipments.

During the past week coastwise coal traffic and foreign cargoes were considerable. Aggregate shipments amounted to 376,038 tons, against 335,502 tons in the preceding week and 366,370 tons in the same week last year. Aggregate shipments for the nine months to date, which amount to 12,532,071 tons, show an increase of over 2,000,000 tons compared with the same period in 1922.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THE outlook in the steam coal trade is not at the moment at all cheerful, inasmuch as the demand from abroad is quieter than ever, with no immediate sign of improving. The natural consequence is that the market reflects the inactivity prevailing in lower prices. A week ago the situation of many collieries was very precarious, for the reason that so much tonnage had been delayed by the bad weather, and it was therefore thought that with the gales moderating, the supply of tonnage available for the collieries would be very much better this week. This, as a matter of fact, turned out to be the case, and many collieries are more comfortably placed, but at the same time the market does not keep steady. The demand for coals of practically all descriptions is much below what is required to put any life into the market, and therefore it is imperative for collieries to reduce their prices in order to compete for the comparatively few orders that come on the market. Business of late has been confined to practically small parcels, which exporters have required to complete cargoes, and they have had no difficulty in securing them at favourable figures, particularly if they have had ready tonnage, thus being able to take immediate shipment, and so release wagons with which to assist to keep the pits working. It is very evident that consumers abroad are in no hurry to operate, and that they prefer to wait developments in the continental political situation. Furthermore, the foreign exchanges have been too erratic to induce buyers to effect purchases unless they are very pressed for supplies, but the majority do not appear to be in very urgent need of coals.

Non-unionist Trouble.

Threats of trouble in different parts of the coalfield are again being made. Applications have been granted to the Llanbradach and Senghenydd lodges to tender notices because a few of the miners in that district have refused to join the Federation. About 4000 men are employed at the collieries affected. A strike was recently threatened on the same question at the six pits of the Lewis Merthyr Company in the Porth district, but this is now not to take place. The notices expired on Saturday last, but the men decided to withdraw them. The miners' agent has stated that the district would take measures to stop all non-unionists from working without the loyal members of the Federation having to cease work on their account.

Anthracite Colliery Development.

Very important developments are shortly to take place at the Hook Colliery, Pembrokeshire. When these are completed, the company expects to have an output of 1000 tons of coal per day, or about half a million tons per annum. This company's property consists of 1500 acres, calculated to contain about 70,000,000 tons of anthracite of the best quality. The company now has a new washing plant under construction, and compressed air machinery driven electrically for working rock drill is being installed underground. The rock seam is the one that is at present being worked, and it has been opened out for an output of close upon 200 tons per day. On the 12th of last month, however, as the result of development work, another seam was cut of 5ft. thickness, and efforts are now being made in three directions to intercept the noted timber seam, which is 9ft. thick, and contains the best quality anthracite in the country. On reaching this seam it is the intention of the company to open three additional collieries immediately.

Steel Trade Items.

It is announced that the result of the joint auditors' report for the three months ending August last gives to the iron and steel workers who follow the South Wales and Monmouthshire wage sliding scale an advance of 6¼ per cent., which will take place as from October 1st. The scale for the current quarter will therefore be 63¾ per cent. above the standard. The steel workers employed at five West Wales works, who had given notices expiring on Saturday, withdrew them so as to enable their claims to be considered in a constitutional manner by the Joint Board. The gas producer men of the Grovesend Steel Works, Gorseinon, who had given notices expiring on Saturday last, came out on strike on Monday, and as a consequence about 700 men were rendered idle. The men persisted in their demand for nearly doubling the rates per ton. The claim, which is not supported by the men's union, is for 4½d. per ton, instead of 2¾d. now paid. The strike of the men did not last long, however, as the men decided on Monday night to resume work and to allow their grievance to be dealt with in a proper manner.

Tin-plate Trade.

The question of the establishment of a tin-plate selling agency which came up a few years ago is being revived. Previously, the proposal came to nothing because of the attitude of one of the largest firms. Now, however, that prices have been stabilised and merchants' commission fixed, the matter is again "on the tapis," and at the last meeting of the Tin-plate Trade Stabilisation Committee a letter was read from two of the largest firms, in which the view was submitted that the trade must either increase the merchants' commission, which is now 1 per cent., or undertake its own selling arrangements. The firms which sent the letter in question favoured the formation of a combined selling agency, but the point which has been raised by some of the owners is with regard to the question of control, inasmuch as the larger concerns would have a preponderating influence, and there is the possibility of interests clashing between those firms which have steel works and make their own bars, and those firms which are smaller and which have to purchase them. The position at the moment is that nothing definite has been come to on the main proposal.

New Llanelly Works.

Reference was made last week to the prospective developments at Llanelly on the part of Messrs. Richard Thomas and Co., tin-plate and steel manufacturers, by the addition of six new mills at their Burry Extension Works. The matter has now been before the Llanelly Corporation, which has been asked to agree to the diversion of a road at Machynis, so as to facilitate the putting down of additional finishing and tinning plant. Naturally, the action of Messrs. Richard Thomas in developing their interests and bringing new works to Llanelly was appreciated by the Corporation, and it agreed to the diversion of the road in question.

Current Business.

There has been quite a dearth of business on the steam coal market during the past week. The position of many of the collieries is rather better than it was last week from the point of view of ready tonnage, but at the same time there are no orders of any importance coming along, and the tendency of foreign consumers appears to be that of holding their hands for the present. The tone of the market for prompt loading is easy in practically all departments, except possibly that for coking smalls, for which there is a fair demand. All other grades are, however, fairly plentiful, and prices are lower as compared with a week ago. While, however, sellers are prepared to make concessions for coals for early loading, they are declining to operate for supplies ahead at the reduced figures. Best Admiralty large are generally quoted at 28s., but buyers experience no difficulty in getting their requirements at 6d. per ton less, while second Admiralty large can be picked up at 26s. 6d. to 27s. The patent fuel trade is quiet, for the reason that the costs of manufacture are relatively high, and the price of this commodity is out of proportion compared with steam coals. Anthracite coals are rather steadier than last week, and nuts and cobbles are quite firm.

Dock Charges.

A meeting of the General Committee of Traders has been held at Cardiff to consider whether application should be made to the Great Western Railway Company for a further reduction in dock charges as from the 1st inst. It was resolved that whilst the Committee considered dock charges in the Bristol Channel had not yet been reduced to an economic level from the traders' point of view, any application for a further reduction should be deferred for a period of three months.

LECTURES.—We are invited to inform our readers that Ed. Bennis and Co. Limited, have a large number of lantern slides dealing with mechanical stokers and mechanical coal and ash handling plant, which they will be pleased to lend to societies, institutions, or individuals for lecturing purposes. Outline lectures can, if desired, also be furnished.

ERRATUM.—In our account of the exhibits at the recent Shipping, Engineering and Machinery Exhibition in last week's issue, a transposition of matter made it appear that the Browning pump was shown on the stand of J. Samuel White and Co., Limited, of East Cowes. In actual fact, Mr. A. G. Browning's pump was exhibited on the stand of the Tangent Tool and Engineering Company, Limited, of Keynsham, Somerset. To all concerned we tender our apologies.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	19/6 to 26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 5 0	—
No. 1 Foundry	5 5 0	—
No. 3 Foundry	5 0 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 19 0	4 19 0
No. 1	5 0 0	5 0 0
Cleveland—		
No. 1	5 2 6	5 2 6
Silicious Iron	5 0 0	5 0 0
No. 3 G.M.B.	4 16 6	4 16 6
No. 4 Foundry	4 11 0	4 11 0
No. 4 Forge	4 9 0	4 9 0
Mottled	4 7 6	4 7 6
White	4 7 6	4 7 6
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge*	—	—
„ „ Foundry	4 10 0 to 5 0 0	
(3) Northampton—		
Foundry No. 3	4 10 0	—
„ Forge	4 1 0 to 4 2 6	—
(3) Derbyshire—		
No. 3 Foundry	4 11 0	—
Forge	4 6 0 to 4 2 6	—
(3) Lincolnshire—		
Basic	4 12 0	—
No. 3 Foundry	4 13 0	—
No. 4 Forge	4 11 0	—
(4) N.W. Coast—		
N. Lancs and Cum.—		
Hematite Mixed Nos.	5 12 6	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 0 0	—
Best „	—	—
N.E. Coast—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
Lancs.—		
Crown Bars	12 0 0	—
Second Quality Bars	11 5 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	12 0 0	—
Best „	13 0 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	12 0 0 to 12 10 0	
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 15 0	—
Gas Tube Strip	12 10 0 to 12 12 6	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 0 0	—
Ship Plates, ¼in. and up	10 0 0	—
Sections	9 15 0	—
Steel Sheets, 3/16in. to ¼in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 17 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	9 15 0	—
Angles	9 5 0	—
Boiler Plates	13 0 0	—
Joists	9 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	12 10 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 10 0†	—
Light „	11 0 0†	—
Billets	8 0 0†	—
Manchester—		
Bars (Round)	10 5 0 to 10 10 0	
„ (others)	10 0 0 to 10 2 6	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	9 15 0 to 10 0 0	
„ (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 0 0	—
Hoops	12 10 0	—
Soft Wire Rods	12 0 0	—
Midlands—		
Small Rolled Bars	9 10 0 to 9 15 0	
Billets and Sheet-bars	7 15 0 to 8 5 0	
Gas Tube Strip	10 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	19 0 0 to 19 5 0	
Angles	9 10 0	
Joists	9 10 0	—
Tees	10 10 0	—
Bridge and Tank Plates	10 0 0 to 10 5 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	23/1½ to 23/3
Block Tin (cash)	202 0 0
„ (three months)	201 17 6
Copper (cash)	61 12 6
„ (three months)	62 5 0
Spanish Lead (cash)	26 5 0
„ (three months)	25 15 0
Spelter (cash)	33 0 0
„ (three months)	32 7 6
Manchester—	
Copper, Best Selected Ingots	67 10 0
„ Electrolytic	69 0 0
„ Strong Sheets	96 0 0
„ Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0
„ Condenser	0 1 2½
Lead, English	27 0 0
„ Foreign	25 10 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 per lb.	
Ferro Tungsten	1/5½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
„ 6 p.c. to 8 p.c. „	£21 0 0	8/-
„ 8 p.c. to 10 p.c. „	£20 0 0	8/-
„ Specially Refined		
„ Max. 2 p.c. carbon	£30 0 0	18/-
„ „ 1 p.c. „	£60 0 0	21/-
„ „ 0.75 p.c. carbon	£70 0 0	22/6
„ carbon free	1/6 per lb.	
Metallic Chromium	4/3 per lb.	
Ferro Manganese (per ton)	£18 for home, £20 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
„ „ 75 p.c.	£19 10 0 scale 6/- per unit	
„ Vanadium	18/- per lb.	
„ Molybdenum	9/- per lb.	
„ Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£130	
Cobalt	11/6 per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

	Export.
Scotland.	
Lanarkshire—	
(f.o.b. Glasgow)—Steam	20/-
„ „ Ell	21/0
„ „ Splint	22/- to 24/-
„ „ Trebles	24/3
„ „ Doubles	23/9
„ „ Singles	22/3
Ayrshire—	
(f.o.b. Ports)—Steam	20/-
„ „ Splint	22/-
„ „ Trebles	24/3
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	20/3 to 22/6
Screened Navigation	27/6
Trebles	27/
Doubles	24/-
Singles	22/6
Lothians—	
(f.o.b. Leith)—Best Steam	22/6
Secondary Steam	21/-
Trebles	26/-
Doubles	24/-
Singles	22/9
England.	
(8) N.W. Coast—	
Steams	31/6
Household	46/8 to 57/6
Coke	46/-
Northumberland—	
Best Steams	24/- to 24/6
Second Steams	22/6 to 23/-
Steam Smalls	14/6 to 16/-
Unscreened	20/6
Household	25/- to 28/-
Durham—	
Best Gas	24/- to 25/-
Second	22/6 to 23/6
Household	25/- to 28/-
Foundry Coke	50/- to 52/6
Sheffield	Inland.
Best Hand-picked Branch	29/6 to 31/- —
Barnsley Best Silkstone	26/6 to 28/- —
Derbyshire Best Brights	25/- to 27/- —
„ „ House	22/6 to 23/6 —
„ „ Large Nuts	20/- to 21/6 —
„ „ Small „	15/- to 16/- —
Yorkshire Hards	21/- to 23/- —
Derbyshire „	20/- to 22/- —
Rough Slacks	11/6 to 13/6 —
Nutty „	10/- to 12/- —
Smalls	7/- to 9/- —
Blast-furnace Coke (Inland)	33/- to 34/-
„ „ (Export) f.o.b.	40/- to 42/-
Cardiff— (9) South Wales.	
Steam Coals :	
Best Smokeless Large	27/6 to 28/6
Second „ „	26/6 to 27/-
Best Dry Large	28/- to 28/6
Ordinary Dry Large	26/- to 27/-
Best Black Vein Large	27/- to 27/6
Western Valley „	26/- to 27/-
Best Eastern Valley Large	25/- to 26/-
Ordinary „ „	24/- to 25/-
Best Steam Smalls	18/- to 19/-
Ordinary „	16/- to 18/-
Washed Nuts	27/6 to 30/-
No. 3 Rhondda Large	28/- to 29/-
„ „ Smalls	24/- to 25/-
No. 2 „ Large	23/- to 24/-
„ „ Through	18/6 to 20/6
„ „ Smalls	15/- to 16/-
Coke (export)	40/ to 47/6
Patent Fuel	29/- to 33/-
Pitwood (ex ship)	27/6 to 29/6
Swansea—	
Anthracite Coals :	
Best Big Vein Large	47/6 to 50/-
Seconds	35/- to 40/-
Red Vein	32/6 to 35/-
Machine-made Cobbles	62/6 to 65/-
Nuts	57/6 to 60/-
Beans	45/- to 47/6
Peas	27/6 to 30/-
Breaker Duff	12/6 to 13/-
Rubbly Culm	15/- to 16/-
Steam Coals :	
Large	25/- to 26/-
Seconds	22/- to 23/-
Smalls	14/- to 16/-
Cargo Through	20/- to 22/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

* Quotations extremely high and nominal. † Latest quotations available.

French Engineering Notes.

(From our Correspondent in Paris.)

Tractors.

THE trials of ploughing tractors carried out last week at Essonnes showed that the engineer is profiting more and more from his collaboration with the farmer, and he is at the same time appreciating the difficulties of the problem of providing the agriculturist with a machine which has to satisfy very complicated requirements. The builder of a tractor only begins to overcome these difficulties when he can demonstrate to the farmer the machine's capacity to turn over the soil in the approved manner. However good the work may be, the machine will not be acceptable unless the cost of ploughing an acre of land is not more than what it actually costs with animal traction, and the farmer must also be assured of being able to till all kinds of soil under every condition of humidity, for while he knows that the ground should be ploughed when it contains a certain degree of moisture, he cannot always adhere to these conditions. At Essonnes the clayey soil was friable at the surface and very hard at a depth of 6in., with the result that while the light tractors gave satisfactory results, the heavier machines found the task difficult. In fact, a plough drawn by a team of oxen would have turned the soil to a greater depth and in a more satisfactory manner than the tractor. The interest of the trials therefore lay in determining the types of machines most suitable for ploughing to depths of 6in. to 8in. in compact soil. Scarcely any of the light tractors could till to a depth of 6in., which is, nevertheless, quite sufficient for many kinds of cultivation, and amongst the most successful of the machines were the Citroën-Kergesse endless rubber track vehicles which accomplished quite satisfactory work, considering the speed at which the machine travelled. With a view of economising fuel consumption, the machines were all driven too fast on a ground that required low speeds to break up the hard subsoil. On such ground the Somua rotary machine probably made the best preparation for the seed bed. On the whole, the tractor displayed its limitations, and is so far from being a universal machine that certain types are obviously only suitable for particular conditions of cultivation, which, moreover, are sufficiently varied to open up a wide field, if farmers can be satisfied that they are able to secure economies from their use.

Cable Ploughing.

The fact that there should be no new tractors at the Essonnes trials showed that engineers have come to a pause, for the reason chiefly that they are undecided how the fuel problem will be solved in the future. For the moment, further prominence is given to cable ploughing for light tillage. Nearly all the light ploughing sets presented at previous trials seem to have dropped out, but at Essonnes a particularly interesting light tackle, known as the "Joya," was shown, its value lying principally in the fact that the whole equipment is in charge of one man. The power plant consists of a 6 horse-power engine driving two drums, and its special feature is the arrangement whereby the drums can be clutched and declutched at a distance by the man guiding the plough. The two dog clutches are actuated by an arm pivoted at the centre and controlled by long levers underneath the vehicle. The cable from the drums passes through the ends of these levers. When, therefore, the man wishes to start the plough, he pulls on the cable which raises the lever and the drum is clutched. In the same way, to stop the plough he pulls on the trailing cable which raises the second lever and declutches the drum. The cable passes around three pulleys, one of which is hooked on to a cable fixed by iron stakes along the side of the field, so that it can be slipped along as new furrows are opened up. The consumption of petrol is said to be 2.6 pints an hour. The advantage of the cable system is that ploughing can be effected irrespective of the humidity of the soil and even on hillsides. For deep ploughing the De Dion–Bouton cable system is frequently employed. The only other method of utilising the motive power to the best advantage is the motor plough, of which the most practical examples were shown by Czecho-Slovakian firms. The engine and transmission gear being balanced on two wheels of large diameter, the motor plough has a high efficiency, and the Excelsior machine broke a number of shares trying to plough the stiff clay soil to a normal depth, this being due, of course, to the speed.

The Fuel Problem.

The development of mechanical cultivation is arrested entirely by the question of fuel cost. The State has imposed upon users a "national fuel," composed of a mixture of petrol and alcohol, on the plea that the country should be rendered as far as possible independent of foreign supplies of oil, but the fuel has been rendered compulsory more especially because the State must dispose of the enormous stocks of alcohol that have been accumulating by reason of the monopoly which was created, mainly to give satisfaction to the viticultural community. The "national fuel" can only be successful on condition of its selling price being not more than that of petrol for the same calorific power. To attain that end, the State has resorted to all kinds of fiscal expedients, whereby the price of petrol is increased and alcohol is cheapened at the expense of petrol users, as well as of the ratepayers generally. It is considered doubtful whether the State can continue that policy indefinitely, and until consumers know what the future course of events is likely to be, there is naturally some hesitation in embarking upon a programme of tractor construction which may eventually terminate in failure. For the moment, the only promising outlook lies in the employment of suction gas plants using wood or charcoal as a fuel. At Essonnes there was a category of tractors with suction gas equipments, with which the Comité Central de Motoculture carried out consumption tests. There were six tractors and four systems of suction gas plants, and they seem to have given satisfactory results. An American tractor with a Vierzon gas producer showed the possibility of economically utilising some thousands of vehicles with slow-running horizontal engines that were imported after the Armistice, and are now encumbering the depôts of machinery agents all over the country.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

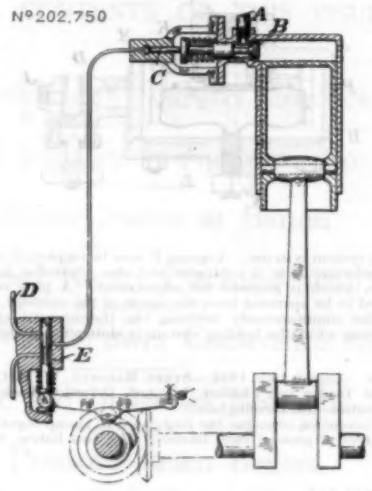
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

202,750. May 30th, 1922.—VALVE GEAR, R. P. Doxford and K. O. Keller, Pallion Yard, Sunderland.

The inventors propose to operate the starting air admission valve by hydraulic means. The air supply is marked A and the

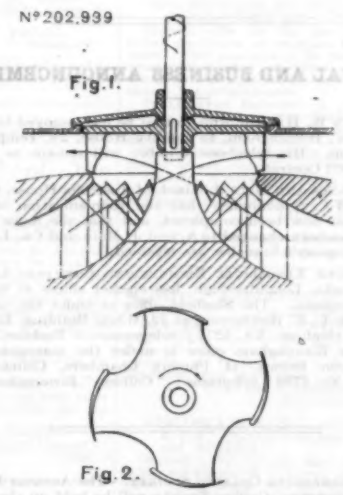


controlling valve B. This valve is operated by means of the plunger C, which is supplied with oil under pressure from the pipe D. The oil is taken from the fuel supply and its admission to the plunger C is regulated by the cam-operated valve E.—*August 30th*, 1923.

TURBINE MACHINERY.

202,939. April 27th, 1922.—HYDRAULIC TURBINES, The English Electric Company, Limited, Queen's House, Kingsway, London, W.C. 2, and P. Deriaz.

In accordance with this invention the runner, which is of a form suitable for centrifugal flow (i.e., for the passage of the water from the inside to the outside of the ring of blades), is combined with an introductory guide arrangement by which the water has imparted to it a vortex motion prior to its entry or

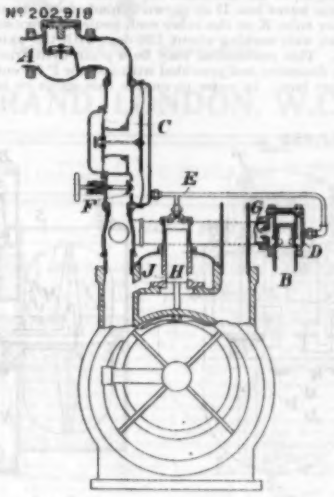


during its entry into the space within the runner blades. By this means it is rendered unnecessary to arrange guide blades inside the runner, since the required direction can be given to the flow of the water within the runner by the action of the guiding arrangement through which it has previously passed. This direction persists owing to the establishment of a stable vortex. The arrows in the illustration Fig. 1 show the direction of flow of the water, while a plan of the runner is given in Fig. 2.—*August 27th*, 1923.

PUMPING AND BLOWING MACHINERY.

202,919. February 22nd, 1923.—GAS MIXERS, J. Keith and Blackman Company, Limited, and G. Keith, 27, Farringdon-avenue, London, E.C.

The object of this invention is to provide a gas and air mixer and compressor which will always deliver a steady supply of combustible. The gas is introduced at A and the air at B. In the gas inlet there is a governor C, which is controlled by the pressure at the air inlet valve D, the connection for this purpose being shown at E. The gas is also controlled by the hand regulating valve F, while the air is drawn through a fixed orifice G. The result is a constant proportional mixture of the gas and air. The pressure of delivery of the mixture is regulated by the

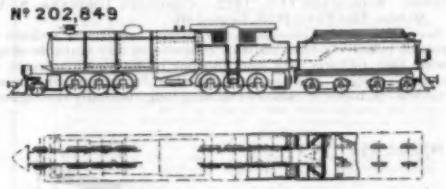


valve H, which opens a by-pass J if the pressure rises too high.—*August 30th*, 1923.

LOCOMOTIVES.

202,849. August 31st, 1922.—STEAM LOCOMOTIVES, Lieut.-Colonel E. Kitson Clark, Airdale Foundry, Leeds, and T. H. Brocklebank.

The object of this invention is to provide an improved locomotive of the articulated type. A locomotive of this type comprises an engine and tender combination which is distinguished from others in that whereas the boiler and cab portions are mounted upon pivoted engine-driven bogie arrangements, the fuel and water are carried by a tender superstructure

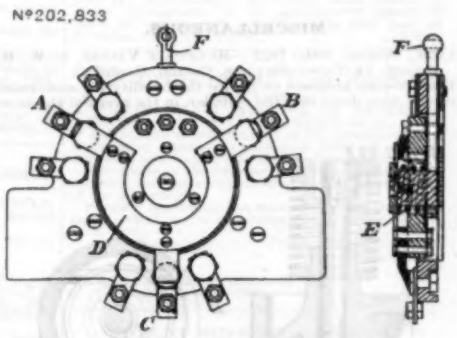


separately mounted upon ordinary carrying wheels and axles or non-engine-driven bogie arrangements, the tender having a chute delivering the fuel on to a receiver stationarily arranged within the engine cab at the customary standard distance from the fire-hole. In this way a locomotive is obtained in which the engine proper is completely articulated and substantially unaffected by variations in the tender load, so that the engine adhesion to the rails is constant. The drawing is self-explanatory. —*August 30th*, 1923.

SWITCHGEAR.

202,833. August 16th, 1922.—SWITCHES, J. B. Hansell, 121, Eccles Old-road, Pendleton, Manchester; and the Metropolitan-Vickers Company, Limited, 4, Central-buildings Westminster.

This switch is specially intended for changing the tapping connections of transformers. The three groups of tapping



terminals are shown at A, B and C The moving contacts are fixed on the disc D and are held up to the terminals by the spring E. The disc is rotated, to change the connections, by the spindle F, which acts somewhat in the same manner as a pinion and crown wheel.—*August 30th*, 1923.

MEASURING AND TESTING INSTRUMENTS.

202,758. June 1st, 1922.—GAS METERS, Sir H. Cowan, and Parkinson and W. B. Cowan, Limited, Fitzalan-street Works, Kennington-road, London, S.E.

This meter has a standard duplex measuring drum A of a size suitable for passing about 30 cubic feet of gas per hour and a standard meter front B with a float chamber C, waste water box D and face-plate E formed as a casting and provided with the requisite float F and tubes G and H operating on the bird fountain principle. The spout I may include an inner tube J open at both ends, of which spout the dimensions by way of example may be of the following order, namely, for the inner tube, about 3¼in. long and ¼in. in diameter. Around it a second tube K is fixed of about ½in. in diameter, leaving an annular space L. This tube K is closed at its ends, but is provided in the outer wall at each end with two connections at M at one end into the measuring drum and at N at the other end to the waste water box D. The connection M into the measuring drum is tapered

from a diameter about ¾in. to a diameter about ½in., the height of the top end of the spout being above the water line—say, about 1.3in. above the centre line of the tubes—and its axis at right angles to the aforesaid centre line. The connection N to the waste water box D as shown is made from the outer wall of the outer tube K at the other end, projects downwardly and is set on an axis making about 130 deg. with the axis through the tubes. This connection may be a plain cylindrical tube O about ¼in. diameter and provided with a screw P for entering the waste water box. In order to enable this spout to be utilised

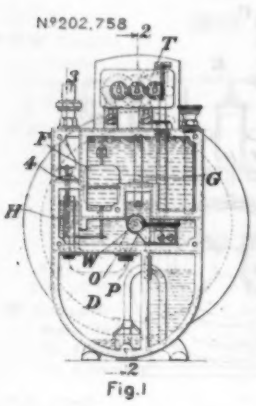


Fig.1

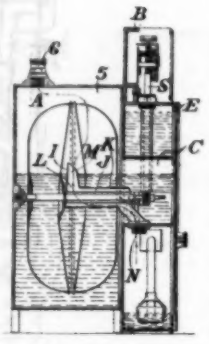


Fig.2.

part of the standard casting needs to be removed to allow the spout to pass into the measuring chamber. The gas passes into the meter through the inlet pipe 3 by way of the inlet valve 4 to the tube or stand pipe H and to the waste water box D, from which it flows through the lower part N of the spout I into the annulus L, emerging at the upper part M into the measuring drum A. From this it escapes into the surrounding chamber 5 and passes to the outlet 6. Excess water from the measuring chamber passes to the waste water box D by way of the stand pipe H. A special form of pivot for the front end of the drum spindle is also described.—*August 30th*, 1923.

BUILDING.

202,856. September 11th, 1922.—Concrete Groynes, S. W. Mobbs, The Town Hall, Lowestoft.

According to this invention the groyne consists of a chain or series of relatively thin slabs of concrete of any suitable shape placed face to face with one another in either an upright or inclined position and secured together by means of chains, flexible rods, ropes or cables extending longitudinally throughout

the series of slabs. The latter are thus more or less loosely strung on the chains or ropes, and the individual slabs are therefore capable of automatically adjusting themselves to a small extent in a direction perpendicular to the length of the groyne, so that when the groyne is in position on the beach or foreshore the groyne automatically accommodates itself to the contour of the ground, resting thereon like an extended chain, as shown in the illustrations.—*August 30th*, 1923.

MISCELLANEOUS.

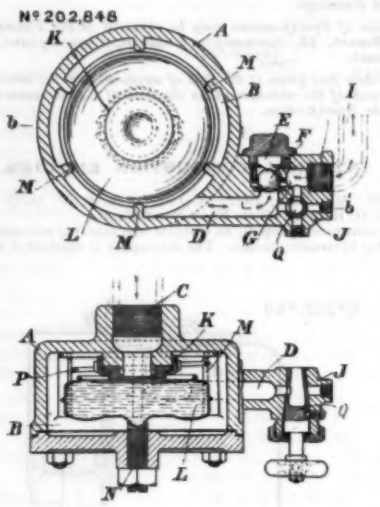
202,829. August 10th, 1922.—Mushroom Valves, S. W. B. Renouf, 18, Tuberville-place, Canton, Cardiff.

The inventor proposes to reduce the liability for mushroom valves to drop down into the cylinder, in the event of the stem

breaking, by providing them with an enlargement or flange A which engages with cross pins B in the valve box, if the stem breaks, and thus prevents the valve from dropping.—*August* 30th, 1923.

202,848. August 31st, 1922.—Steam Traps, B. Coathupe, 33, Wardour-street, London, W. 1.

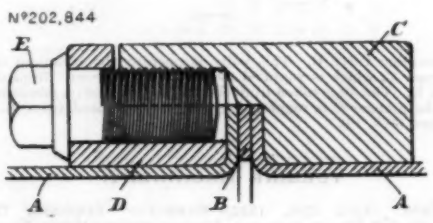
The object of this invention is to conserve the water discharged by the steam traps of railway carriage radiators and use it for such purposes as lavatories, &c. The water of condensation passes into the casing A at its inlet C over the thermostatic diaphragm L into the diaphragm chamber B. The pressure of steam forces the water to lift the ball F or check valve and pass through the pipe I attached to the casing A for conveying the water to a tank. When the system is freed from water the steam coming in contact with the thermostatic diaphragm L causes it to expand on its seat, closing the inlet C to the chamber and stop steam escaping from the radiators. The check valve F, preferably of the ball type, prevents any water in the pipe returning into the diaphragm chamber. As water collects again the temperature being lower than the steam, causes the thermostatic diaphragm L to contract and allows the water to pass as before described. This automatic action continues so long as the



heating system is in use. A spring P may be employed to assist the diaphragm L as it contracts and also centralise it on its stud N, which is screwed for adjustment. A plug cock Q, arranged to be operated from the inside of the carriage, is provided for simultaneously draining the thermostatic chamber and piping when the heating system is shut off.—*August 30th*, 1923.

202,844. August 25th, 1922.—Steel Barrels, W. B. Challen, and Taylor and Challen, Limited, Derwent Works, Constitution-hill, Birmingham.

This invention concerns the rings used to clamp together the two halves of pressed steel barrels. The two halves A A are



flanged over as shown and a rubber ring B is used to make the joint tight. The clamping rings are shown at C and D and are drawn together by screws E. These screws go into holes of which half the circumference is in C and half in D. That part of the hole in C is threaded for engagement with the screw, while the part in D is plain.—*August 30th*, 1923.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Mr. John W. Hall informs us that he has removed from 71, Temple-row, Birmingham, to Quality House, 25, Temple-row, Birmingham. His telephone number will remain as before, namely, 5677 Central.

Armstrongs and Main, Limited, of Australia House, Strand, London, W.C. 2, announce that the reorganisation of their business has now been completed, and that the name of the company hasbeen changed to A. and J. Main and Co., Limited. All the company's branches are retained.

The Brush Electrical Engineering Company, Limited, Falcon Works, Loughborough, has opened offices at Sheffield and Birmingham. The Sheffield office is under the management of Mr. C. E. Brotherton, at 32, White Building, Fitzalan-square. Telephone No. 5277; telegrams: "Turbine," Sheffield. The Birmingham office is under the management of Mr. Malcolm Brown, at Phœnix Chambers, Colmore-row. Telephone No. 5799; telegrams: "Colbree," Birmingham.

The Engineering Golfing Society.—The Autumn Meeting of the Engineering Golfing Society will be held on the course of the Addington Golf Club on Wednesday, the 10th inst. In the morning there will be an 18-hole medal round for the "Hele-Shaw" Scratch Challenge Cup and Memento. Prizes also will be given for the best and second best scores (First Division for handicaps of 10 and under, Second Division for handicaps of 11 and over), and for the best net scores for each nine holes—Nos. 1–9 and Nos. 10–18 (under half handicap, fractions to count). In the afternoon there will be foursomes, 18-hole match play against bogey, for the "Hadfield" Challenge Cups. Mementoes and second prizes will be given.

Gear Grinding.—A catalogue which has just been issued by the Gear Grinding Company, Limited, of Handsworth, Birmingham, illustrates very effectively the process used by the company in finishing the teeth of gear wheels, in which a formed abrasive wheel is used rather than the generating system. It is held that the formed wheel method is preferable, as a considerable amount of material can be removed more expeditiously, while the accuracy attained is equally good. If necessary, as much as 0.03in. can be removed from each side of the tooth spaces, so it is possible to machine the gear wheels quite roughly, and distortion during hardening is readily put right during the subsequent grinding. Over and above the great advantage of silence the ground gears have the merit that they can be run at very high speeds, while the wheels can be made of material having the highest factor of safety.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Diesel Engine Users' Association.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Discussion on "Some Notes on a Broken Crank Shaft, &c."

Junior Institution of Engineers.—39, Victoria-street, S.W. 1.—Lecturette, "Design of Underground Cable Systems," by Major A. M. Taylor. 7.30 p.m.

SATURDAY, OCTOBER 6TH.

Institute of British Foundrymen: Lancashire Branch.—College of Technology, Sackville-street, Manchester. Presidential address by Mr. R. A. Miles; lecture, "Pig Iron and its By-products," by Mr. J. M. Paul. 4 p.m.

West Yorkshire Metallurgical School.—George Hotel, Huddersfield. Annual general meeting. 7 p.m.

MONDAY, OCTOBER 8TH.

Bradford Engineering Society.—Technical College, Bradford. Presidential address, "The Engineer's Place in Industry," by Mr. Landor Baldwin. 7.30 p.m.

TUESDAY, OCTOBER 9TH.

Institute of Marine Engineers.—85–88, The Minories, Tower-hill, E. 1. "The Pyramids of Egypt," by Mr. W. J. L. Vanstone. Lantern views. 6.30 p.m.

Institution of Petroleum Technologists.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper, "Recent Research Bearing upon the Origin of Petroleum," by Mr. E. H. Cunningham Craig. 5.30 p.m.

Institution of Heating and Ventilating Engineers.—Caxton Hall, Room 13, Broadway, S.W. 1. Paper, "London County Hall: Facts, Figures and Reflections," by Messrs. P. M. B. Grenville and T. Moodie. 7 p.m.

WEDNESDAY, OCTOBER 10TH.

Engineering Golfing Society.—Autumn Meeting on the course of the Addington Golf Club. 10 a.m.

Institution of Engineers-in-Charge.—St. Bride Institute, Bride-lane, E.C. 4. Presidential address, "Engineering Records and Their Value to the Engineer-in-Charge." 7.30 p.m.

Institution of Welding Engineers.—Holborn Restaurant, W.C. 1. Papers on "Electric Welding" and "Gas Welding." 8 p.m.

Societe des Ingenieurs Civils de France: British Section.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Presidential address by Mr. Roger T. Smith. 6 p.m.

Institution of Automobile Engineers.—Royal Automobile Club, Pall Mall, S.W. 1. Presidential address, "Automobile Engineering as a Profession," by Mr. H. G. Burford. 8 p.m.

THURSDAY, OCTOBER 11TH.

Northampton Engineering College Engineering Society.—St. John-street, E.C. 1. Presidential address by Dr. R. M. Walmsley. Paper, "Fatigue," by Mr. C. E. Larard. 5.30 p.m.

FRIDAY, OCTOBER 12TH.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Paper, "The Never-Stop Railway" (slides), by Mr. W. Yorath Lewis. 7.30 p.m.

SATURDAY, OCTOBER 13TH.

Junior Institution of Engineers.—Visit to the works of the Gas Light and Coke Company, at Beckton. 2 p.m.

MONDAY, OCTOBER 15TH.

Institute of Marine Engineers.—85–88, The Minories, E. 1. Extraordinary general meeting for confirmation of alterations to by-laws. 6.30 p.m.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. Presidential address, "Automobile Engineering as a Profession," by Mr. H. G. Burford. 7.30 p.m.

THURSDAY, OCTOBER 18TH.

Royal Aeronautical Society.—Royal Society of Arts, 18, John-street, Adelphi, W.C. 2. "The Manœuvres of Inverted Flight," by Squadron-Leader R. M. Hill. 5.30 p.m.

CONTRACTS.

Scott Brothers (Keighley) inform us that they have been awarded contracts for eight shaping machines by the Air Ministry and for two large double-ended punching and shearing machines by the Australian Governments.

The Leeds Forge Company, Limited, Leeds, has received an important order from the High Commissioner for South Africa for three hundred and fifty bogie wagons, each of 40 tons capacity. These wagons are for the conveyance of grain in bulk from the farming districts to South African ports, and are specially designed to suit the elevator system which is now being installed at the main up-country stations, and at the ports of Capetown and Durban.

Meldrums Limited, of Timperley, near Manchester, have recently received orders for twenty-nine forced-draught furnaces in all, the orders coming from bleach works, brickworks, collieries, motor manufacturers (repeat), engineers, sizers, a county hospital, laundries, tar distillers, chemical works, a residential hotel, tanners, brewers, gasworks, and economiser makers. The same firm has also received orders for four destructors, for two gas washer scrubbers of 5,000,000 cubic feet capacity each and for two of 10,000,000 cubic feet capacity each for coke oven plants, and for elevators for wood pulp for large paper factory.